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COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 9

The Estimation of Recent Trends in Fertility and Mortality in Egypt

Panel on Egypt
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

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Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded initially for a period of three years by AID under Contract No. AID/pha-C-1161. The committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Best estimates of levels and recent trends are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one committee member, is to carry out the comparisons and analyses required. A small staff assists the committee, panels, and working groups in their work.

As of late 1981, 168 population specialists, including 94 from developing countries, have been involved in the work of the committee as members of panels or working groups. The committee, the assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report, on levels and trends of fertility and mortality in Egypt, is number 9 in a series produced by the committee. In 1978 General Gamal Askar, President of the Central Agency for Public Mobilisation and Statistics (CAPMAS), assisted the Committee on Population and Demography in establishing the Panel on Egypt. The panel met on three occasions to plan the project and to review analyses and findings. The work leading to this report was carried out by panel members, assisted by staffs of CAPMAS and the committee. General Askar and I served as co-chair of the panel. General Askar had primary responsibility for the assembling and initial processing of relevant data for the report, while I had primary responsibility for supervising and carrying out the analysis.

Many readers of this report will know of General Askar's tragically premature death in January 1981. Before he died he provided several pages of comments on the draft manuscript. It is particularly regrettable that he was unable to see the published report since the report owes so much to his interest in the project. General Askar believed that a report summarizing the levels and trends in fertility and mortality in Egypt during recent decades would serve the interests of the Egyptian government and the Egyptian population as long-range plans are made for the economic and social development of the country. The report is a tribute to his interest and support.

The project benefited from much detailed work carried out by many members of the staff at CAPMAS, including preparation of data from the 1976 census and the civil registration system, and assistance in compiling a bibliography that illustrates extensive previous writing on the demography of Egypt. In addition, during the course of this study CAPMAS provided to the panel a series of detailed tabulations from the 1976 census. The data include tabulations of numbers of children ever born and surviving, by mother's age, duration of marriage, and educational attainment. The committee staff entered these data into computer files to produce tabulations that helped the panel assess the nature of Egyptian demographic information and construct estimates of childhood and infant mortality. The latter estimates were in turn used to construct estimates of fertility by means of reverse projection. It is not feasible to reproduce all of these detailed tabulations in this report, but copies can be made available. The tabulations exist by governorate and for urban and rural areas of each governorate.

The committee wishes to express thanks to all members of the panel, who are listed above. As indicated, special thanks are due to the staff of CAPMAS who helped put together necessary tabulations and other information for panel members, including: Saad Zaghloul Amin, Reda El-Sayed Kandil, Farag Sedki Mourad, Amal El Ghamry, Neamat El-Henawy, Noshi Orabi, Raafat Abdel-Hamid, Taher Onyn, Nassef Mohammed Nassef, Mohammed Fetouh, Mostafa Gaafar, and Gihad El-Meikati.

Thanks are also due to the staff of the Committee on Population and Demography, especially to Jane Durch who collaborated with me in much of the detailed analysis. Her careful work on tedious procedures is much appreciated. At an earlier stage Ms. Durch also assisted with necessary computer work, as did Hania Zlotnik of the committee staff. Thanks are also due to the committee's editor, Katherine Miller, who provided much editorial advice, and to Elaine McGarraugh, Assembly editorial assistant, for her careful guidance during the production of this report. The assistance of the committee's staff in typing the draft and final copy of the text and tables is acknowledged with appreciation. Particular thanks are offered to Benita Anderson and Solveig Padilla.

The panel's work included a careful assessment of duration-specific marital fertility in Egypt during the periods 1950-61 and 1966-75. Shafiq El Atoum, professor of statistics at the University of Jordan, assisted with this part of the work program while spending a postdoctoral year of study at Princeton University 1978-79. The panel expresses appreciation to Dr. Atoum for his participation in the project.

Finally, the report has benefited from comments and insights provided by members of the committee and the Assembly of Behavioral and Social Sciences of the National Research Council, and by Ismail Sirageldin, in their reviews of the manuscript.

ANSLEY J. COALE, Chair
Committee on Population and Demography

Summary

In Egypt both fertility and mortality were high until after World War II, but the difference between the birth and death rates was enough to sustain a moderately rapid increase in population. Between 1897 and 1947, according to census counts, the Egyptian population nearly doubled, rising from 9.7 to 19.0 million--an average annual increase of more than 1.3 percent. Beginning in the late 1940s, both infant mortality and the crude death rate began an extensive decline. By 1976, the infant mortality rate was less than half what the rate had been in the 1930s and the expectation of life at birth had risen from about 30 to about 50 years. During the same period, expectation of life at age 10 rose only by about 10 years to about 55 years.

The birth rate fell temporarily during World War II but returned to pre-war levels in the late 1940s. As recently as 1960 and 1961, the birth rate was still an approximate extension of the plateau that characterized the rate before World War II and in the post-war years. Between the early 1960s and the early 1970s, the birth rate declined by some 20 percent and then rose slightly from 1972 to 1977.

The birth rate can be estimated for 1977-79 on the untestable assumption that underregistration of births continued at the same level as for previous years. The birth rate calculated on this assumption continued to rise slightly in 1977 and 1978 to just above 40, and then jumped to 44 in 1979. A 10 percent increase in the number of reported births in one year suggests the possibility that delayed registration may have played a part. Figure 1 shows the approximate values of the birth rate and four measures of mortality for the half century 1927-76. The unusually rich demographic data for Egypt permit the construction of these and other estimates, after adjustments necessitated by the imperfect accuracy of the data.

Most of the 40 million people of Egypt live in the Nile valley and delta which includes three major regions: Cairo and Alexandria, Lower Egypt, and Upper Egypt. Fertility and mortality levels vary among the regions of the country, and some of the differentials have changed in recent decades. In 1946-47 infant mortality was about 213 per thousand live births, with estimated rates of 187 in Cairo and Alexandria, 204 in Lower Egypt, and 259 in Upper Egypt. The rate for Upper Egypt was 39 percent higher than in Cairo and Alexandria, and 27 percent more than in Lower Egypt. By 1975-76 infant mortality had declined by 40 percent or more in all regions, but the rate for Upper Egypt (145) was almost half again as great as in Lower Egypt (99), and a third higher than infant mortality in Cairo and Alexandria (109). Since the end of World War II the gains in infant mortality have been greatest in Lower Egypt.

Fertility rates also vary by region. In 1946-47 the crude birth rate was almost the same in Cairo and Alexandria (47) as in the rest of Egypt (48), but by 1975-76 the crude birth rate ranged from about 32 in Cairo and Alexandria to about 45 in rural Upper Egypt. The total fertility rate, a more accurate measure of fertility levels and trends, was about 6.5 in Egypt in 1937, about 6.3 in 1946-47, up to 6.7 in 1959-60, and down to 5.5 in 1975-76. Regional differences were slight in 1946-47 and somewhat larger in 1959-60 when Cairo and Alexandria had a total fertility rate of 5.9 compared with 6.9 in Lower Egypt and 6.8 in Upper Egypt. By 1975-76, the range was greater and more differentials appeared, for example, 3.9 in Cairo and Alexandria, 5.0 in urban Lower Egypt, 6.0 in rural Lower Egypt, and 6.8 in rural Upper Egypt.

Four other fertility measures are used in this report, including the general fertility rate (200 in 1936-37 declining to 167 in 1975-76), and three indexes of fertility that measure overall fertility, marital fertility and the proportion married among women of childbearing age (I_f, I_g, and I_m). The index of overall fertility, I_f, is the ratio of the number of births occurring in a population to the theoretical maximum number of children that could be produced. The index was just over .50 before and after World War II, and slightly higher in 1959-60, with some regional variation: i.e., .48 in Cairo and Alexandria and about .55 in Lower and Upper Egypt. For 1975-76 I_f showed substantial regional variation, from .31 in Cairo and Alexandria to .55 in rural Upper Egypt, with a level of .45 for Egypt as a whole.

The index of marital fertility, I_g, is the ratio of the number of births occurring to married women to the maximum number of children that married women might have if subject to the maximal fertility rates at each age. For Egypt it was about .68 in 1936-37, slightly higher in 1946-47 and 1959-60, and down to about its previous level of .67 in 1975-76. However, in 1975-76 regional differences were strong: .54 in Cairo and Alexandria and .74 in rural Upper Egypt.

For Egypt as a whole, these more refined measures of fertility suggest a different trend from that of the crude birth rate. Instead of a slight decline, they suggest a rise in fertility in 1960 of 6-8 percent over the 1947 levels. The differences between the crude birth rate and the other measures result from a change in age composition that altered the proportion of women 15-50 within the total population. Between 1947 and 1960 the proportions of women of childbearing age fell by 10 percent because declining infant mortality increased the proportion of children in the population. (After 1960, changes in age composition had little significance for the birth rate as additional reductions in infant mortality were offset by reductions in fertility.) The increase in fertility between 1947 and 1960 was due to slight increases in the proportion married (I_m increased by 2.6 percent) and in marital fertility (I_g increased by 3.2 percent).

The third index, I_m, measures the contribution of marital status to the attainment of maximal overall fertility in a population in which childbearing occurs only among married women (as is the case in Egypt). I_m was about .77 in 1936-37, .75 in 1959-60, and .66 in 1975-76 with a range from .59 in Cairo and Alexandria to .74 in rural Upper Egypt. Thus the proportions of women married were a partial cause of differential fertility among the regions of Egypt.

Between 1960 and 1976 overall fertility (I_f) declined in Egypt by 18 percent. The reduction in the index of the proportion married was greater than the reduction in marital fertility; I_m fell by 12 percent while I_g declined by 6.3 percent. After 1960 there was a marked shift in the frequency of first marriages among younger women. In the age groups 15-19 and 20-24, the proportion single did not change very much between 1937 and 1960, but between 1960 and 1976 substantial increases occurred, from 75 to 83 percent for women 15-19 and from 23 to 39 percent for women 20-24. The singulate mean age at marriage increased by 1.4 years over the years 1960-76. The declines in the frequency of first marriages in the 1960s (the low points were in 1965-69) probably led to the drop in the birth rate in the early 1970s. The increase in the birth rate from 1972 to 1976 was to some degree (perhaps wholly) a consequence of partial recovery from a reduced proportion of married women among younger women of childbearing age.

Thus the reduction in fertility in Egypt over 1960-76 was caused by both later marriage and a small decrease in marital fertility. As is typical in many developing nations, the declines began sooner and were larger in large metropolitan areas. Cairo and Alexandria had lower proportions of married women as early as 1947. Sharp declines occurred in these two cities over 1960-76 in the proportions married (17 percent) and in marital fertility (20 percent). By comparison, during the 1960-76 period, in Lower Egypt the decline in marital fertility was about 5 percent, and in Upper Egypt there was a negligible rise of 1.3 percent. These results are supported by independent measures of the effects of voluntary control of marital fertility in the major regions of Egypt.

1 Introduction

The more than 40 million people of Egypt live crowded onto a tiny fraction of the country's one million square kilometers (386,000 square miles). Set in the northeast corner of Africa, Egypt is roughly 95 percent desert, interrupted only by the country's lifeline, the Nile River, which stretches 1,000 miles from south to north. More than 95 percent of the population lives in the valley along the Nile and in the fertile broad delta that the river has created over millennia. Most of the country is subject to the hot summers, cool winters, and limited rainfall of the desert; only the northernmost areas on the Mediterranean have a more temperate climate, with higher humidity and rainfall.

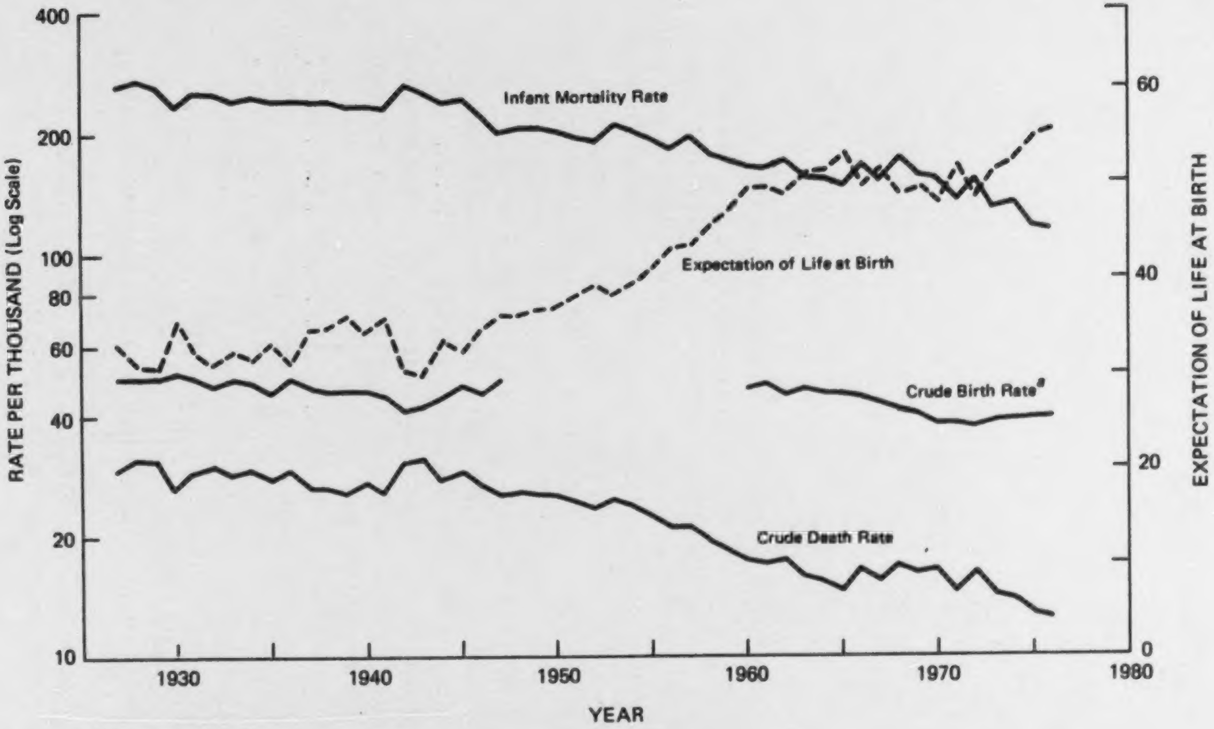
The country's northern boundary is the Mediterranean Sea; Libya lies to the west and Sudan to the south. The Suez Canal, which connects the Mediterranean and the Gulf of Suez, separates the Sinai Peninsula from the main land mass of Egypt. To the east, on the Sinai peninsula, is a short border with Israel. The remainder of the eastern border is coastline along the Gulf of Suez, the Gulf of Aqaba, and the Red Sea.

Egypt's 25 administrative units are called governorates. Two of the most populous are the urban governorates of Cairo and Alexandria. In 1976, Cairo had over 5 million inhabitants and the city of Alexandria had 2.3 million; thus about a fifth of the population resides in these two large metropolises. (The Cairo metropolis is in fact larger because Greater Cairo, which includes part of Giza Governorate across the Nile, had about 8 million people in 1976.) Suez and Port Said are smaller urban governorates on the Suez Canal. At the other extreme are the four frontier governorates, in the Sinai Peninsula and the desert areas east and west of the Nile

Valley, which are inhabited by less than 1 percent of the population. The 17 other governorates are grouped into the two traditional regions of Upper and Lower Egypt. Nine governorates lying in the north in the Nile delta or along the Suez Canal comprise Lower Egypt (Behera, Dakahlia, Damietta, Gharbia, Ismailia, Kafr-el-Sheik, Kalyubia, Menoufia, and Sharkia), while the remaining eight, south of Cairo, constitute Upper Egypt (Assyiut, Aswan, Beni Suef, Fayoum, Giza, Kena, Minya, and Souhag). (See Figure 2.)

Aside from the desert, the dominant feature of life and geography in Egypt is the Nile River. Since ancient times the river has been the principal source of water necessary for agriculture and thus has always defined the population centers of the country. The second longest river in the world, the Nile originates in Uganda and Ethiopia and flows north from these headwaters through Sudan before reaching Egypt's southern border. There the river widens into Lake Nasser, created in 1975 by the completion of the Aswan High Dam. From there, it flows generally northward until it reaches the Mediterranean. In southern Egypt, the river flows through a narrow valley which gradually widens farther north. This southern section of Egypt above Cairo consists of a strip of fertile land often only a mile or two wide along the Nile, surrounded by arid desert. At Cairo, about 100 miles from the sea, the river fans out through a wide, fertile delta.

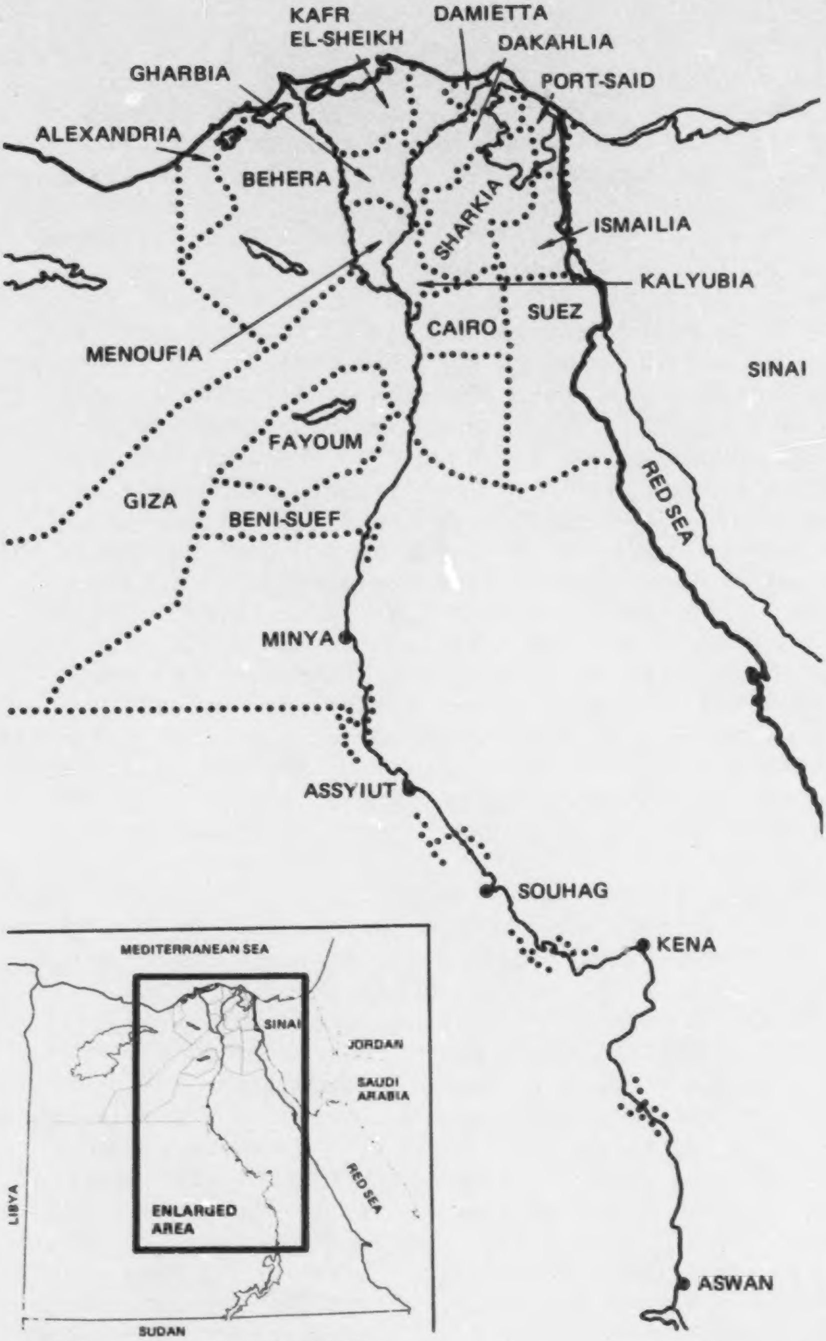
Although the amount of cultivable land in Egypt is extremely limited, agriculture has been and continues to be a major aspect of the Egyptian economy, employing about half the labor force and contributing about a quarter of the gross domestic product. High-quality, long-staple cotton is a main commercial crop, and its export provides a major source of income for the country. Some food crops are also grown for export, but Egypt must import foodstuffs to meet domestic needs. Agriculture in Egypt depends on irrigation with water drawn from the Nile. Historically the annual flooding of the Nile also provided silt, helping to renew the soil. The Aswan High Dam, in addition to providing cheap hydroelectric power, has made it possible to control the annual flooding and to provide a more steady year-round flow of water for irrigation. But the dam also blocks most of the silt which the Nile carries. The long-term effects of this change are not yet clear.



[a]Birth rates were not estimated for 1948-1959.

FIGURE 1 Summary of Fertility and Mortality Estimates, 1927-76: Egypt

Source: Table 2.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ASWAN
MEDITERRANEAN SEA
SINAI
JORDAN
SAUDI ARABIA
RED SEA
LIBYA
ENLARGED AREA
SUDAN

FIGURE 2 Map of Egypt

Table 1 presents several recent socioeconomic indicators for Egypt. On the whole the urban governorates, especially Cairo and Alexandria, are the most advanced in terms of such factors as literacy, occupational structure, and social services (ranging from electrification and running water to doctors and hospitals). Lower Egypt fares less well than the metropolitan areas, but Upper Egypt has experienced the least socioeconomic development.

More than 5,000 years ago, Egypt was the site of one of the major civilizations in world history. After centuries of native rule, the country fell under the influence of a succession of foreign powers, most notably in the last several centuries the Ottoman Turks and, beginning in the nineteenth century, the British. Egypt obtained independence from Great Britain in 1922, and in 1953 a republic was established. Gamal Abdul Nasser was elected and served as president until his death in 1970, when Anwar Sadat became president. Hosni Mubarak became the third president of Egypt following the death of Sadat in 1981.

Today Egypt is basically an Islamic society. Islam was brought to the country in the seventh century as the Arabs established control of most of North Africa. About

TABLE 1 Socioeconomic Indicators, 1974-77: Egypt

Gross national product per capita, 1977[a]	US $320
Percent of gross domestic product from agriculture, 1977[a]	28.0
Percent of labor force in agriculture, 1977[a]	51.0
Percent of labor force that are unpaid family workers, 1974[b]	18.6
Percent of population aged 10 and older that is literate, 1976[c]	43.5
Percent of households with access to purified water, 1976[c]	74.8
Percent of population urban, 1976[c]	43.9
Density of inhabited area (population per sq. mile), 1976[b]	1,881
Dependency ratio (ratio of population under 15 or 65 and over to the population aged 15-64), 1976[c]	.771
Population per physician, 1976[a]	1,190

Sources:

[a] World Development Report, 1979. World Bank (1979).
[b] Population and Development: A Study on the Population Increase and Its Challenge to Development in Egypt. Egypt [CAPMAS] (1978).
[c] Preliminary Results of the General Population and Housing Census, 22/23 November 1976. Egypt [CAPMAS] (n.d.b).

6 percent of the population are Christians, most of whom belong to the Coptic Church. This Christian minority is concentrated in Cairo and in the governorates of Minya, Assyiut, and Souhag in Upper Egypt.

2 Fertility and Mortality Since 1927

The first use of the estimates we have constructed (or assembled) is to provide an outline of the general course of Egyptian fertility and mortality during the past half century. Table 2 presents approximate values of the birth rate, the death rate, the infant mortality rate, and the expectation of life at birth and at age 10 for this period. Since the major change in mortality, and whatever significant decline there has been in fertility, occurred since the late 1940s, the second use of our estimates is to show the course of fertility and mortality in more detail during the last three decades. Detail is increased in two ways: information is presented about geographically defined subsets of the Egyptian population, and measures of fertility more informative than the crude birth rate are introduced. Estimates of mortality above age 5, however, have not been made for regions or governorates.

The tabulation of reported vital events in Egypt provides the basis for estimates of the crude birth rate through 1979 and of the infant mortality rate for 1977. At some risk of error the estimates for these most recent years are constructed by applying estimates of underregistration developed in this report to the numbers of reported events, and by projecting the 1976 population forward to 1979. The resulting birth rate estimates are 40.3 for 1977, 40.4 for 1978 and 44.3 for 1979. The big jump in 1979 results from a large increase in the number of reported births: 1,681,938 in 1979 compared with 1,490,624 in 1978 and 1,460,620 in 1977. The estimated infant mortality rate for 1977 is 113 per thousand live births. Table 2 shows the estimates only through 1976 because more detailed analysis, including use of data from the 1976 census, is possible through that date. The

TABLE 2 Summary Estimates of Fertility and Mortality, 1927-76: Egypt

Year	Crude Birth Rate[a]	Crude Death Rate[b]	Infant Mortality Rate	Expectation of Life at Birth	Expectation of Life at Age 10[c]
1927	49.4	29.3	264	33.0	45.7
1928	49.0	31.3	278	30.7	43.7
1929	49.6	31.0	266	30.6	42.4
1930	51.0	26.6	239	35.4	46.5
1931	49.9	28.9	255	32.5	44.1
1932	47.7	30.0	253	31.0	41.7
1933	49.1	28.6	244	32.3	42.8
1934	48.0	29.3	250	31.5	42.2
1935	45.9	27.7	242	33.2	43.8
1936	49.4	29.1	244	31.3	41.4
1937	47.0	26.6	243	34.5	45.7
1938	46.0	26.5	244	34.8	46.3
1939	46.4	25.6	237	36.0	47.1
1940	46.2	27.2	238	34.4	46.3
1941	45.1	25.9	234	35.7	46.1
1942	41.0	30.7	264	30.5	42.0
1943	42.2	31.1	257	29.8	40.4
1944	44.3	27.9	241	33.4	44.0
1945	47.9	29.0	246	32.3	42.9
1946	45.5	27.0	223	34.4	43.6
1947	49.1	25.5	201	36.1	43.7
1948	--	25.8	209	36.2	44.7
1949	--	25.6	209	36.7	45.3
1950	--	25.4	204	37.0	45.2
1951	--	24.8	199	37.9	45.9
1952	--	23.9	193	39.1	46.8
1953	--	24.9	213	38.2	47.7
1954	--	24.0	205	39.3	48.3
1955	--	22.8	195	40.9	49.2
1956	--	21.1	183	43.1	50.7
1957	--	21.2	196	43.4	52.3
1958	--	19.4	179	45.9	53.6
1959	--	18.3	171	47.3	54.4
1960	46.6	17.4	168	49.2	56.3
1961	47.7	17.1	166	49.4	56.4
1962	45.1	17.4	171	48.9	56.4
1963	46.5	16.0	157	51.0	57.2
1964	45.8	15.6	155	51.4	57.5
1965	45.4	14.7	149	53.1	58.8
1966	44.6	16.5	168	49.7	56.9
1967	42.8	15.4	153	51.4	57.2
1968	41.7	16.9	173	48.8	56.4
1969	40.2	16.1	157	49.4	55.4
1970	38.2	16.4	153	48.1	53.4
1971	38.2	14.4	136	51.8	55.8
1972	37.0	16.1	153	48.4	53.7
1973	38.4	14.3	130	51.3	54.5
1974	38.6	13.9	133	52.4	56.1
1975	39.0	12.8	118	54.9	57.0
1976	39.5	12.6	116	55.4	57.4

TABLE 2 (continued)

[a] Insufficient evidence for estimating the extent of underregistration of births in the period 1948-59.

[b] The crude death rate is determined by choosing a model life table up to age 5 that is matched with the infant mortality rate and a second model life table for above age 5 that is matched with the expectation of life at age 10 (e_{10}). The age specific mortality rates obtained from these life tables are applied to the projected age distribution for each year to obtain the number of deaths, and the projected population is used as the denominator to calculate the crude death rate. These crude death rates, therefore, are not directly comparable with crude death rates calculated from registration data.

[c] Expectation of life at age 10 (e_{10}) is an unweighted average of e_{10} for males and females from adjusted death rates (see Appendix C).

above estimates for years beyond 1976 may be subject to changed reporting practices. For example, the completeness of birth registration may have increased beyond the 96.4 percent level estimated for the period prior to 1976, the extent and patterns of delayed registration may have changed, and shifts in marriage patterns may have affected the crude birth rate. Therefore, the rates for years after 1976 should be used with caution.

INFANT MORTALITY BY GOVERNORATE AND REGION, 1946-47 to 1975-76

We were unable to calculate satisfactory corrections for completeness of registration of non-infant deaths by governorate, hence this more detailed discussion is limited to infant mortality. Table 3 shows estimated infant mortality rates for governorates and for three major regions of Egypt in 1946-47, 1960-61, and 1975-76. The "regions" are the combined urban governorates of Cairo and Alexandria; Lower Egypt, lying between Cairo and the Mediterranean, and encompassing the delta of the Nile; and Upper Egypt, the southern section of Egypt above Cairo. Cairo and Alexandria had the lowest infant mortality rate (IMR) of the three regions in 1946-47, but were overtaken by Lower Egypt in 1960-61 and 1975-76. In all regions the proportionate decline in IMR from 1946-47 to 1975-76 was more than 40 percent. Throughout the period, infant mortality in Upper Egypt was consistently higher than in the other regions. In 1960-61 Upper Egypt infant mortality exceeded the rates in 1946-47 in the rest of Egypt; in 1975-76 infant mortality in Upper Egypt had barely attained the level reached 15 years earlier in the metropolitan populations and in Lower Egypt.

TABLE 3 Estimated Infant Mortality Rates (per thousand) by Region and Governorate, 1946-47, 1960-61, and 1975-76: Egypt

Region and Governorate	1946-47	1960-61	1975-76	1975-76	
				Urban	Rural
Cairo and Alexandria	187.3	149.1	108.7	108.7	--
Cairo	186.4	151.0	113.7	113.7	--
Alexandria	189.3	142.3	98.6	98.6	--
Lower Egypt	203.6	147.2	98.6	95.0	99.7
Damietta	134.0[a]	89.8	93.9	80.0	96.6
Dakahlia	206.2	149.5	90.8	70.8	95.7
Sharkia	207.1	131.4	105.7	90.3	109.1
Kalyubia	244.6	211.4	123.5	127.9	119.6
Kafr-el-Sheik	--[b]	108.2	83.1	74.0	85.5
Gharbia	190.1	147.4	92.6	90.1	93.6
Menoufia	228.7	174.7	110.8	94.8	113.6
Behera	169.0	124.8	87.7	84.6	88.4
Ismailia	--[b]	--[b]	93.3	104.7	84.2
Upper Egypt	259.0	225.0	144.9	126.9	152.6
Giza	265.8	207.3	122.4	117.4	127.4
Beni Suef	284.9	263.2	156.1	135.0	162.6
Fayoum	303.4	196.6	151.8	142.8	154.2
Minya	287.9	237.9	162.2	136.5	168.5
Assyiut	259.5	224.4	148.6	126.8	154.9
Souhag	228.1	219.0	134.1	122.1	137.8
Kena	237.0	237.8	153.1	128.4	160.7
Aswan	210.0	204.1	148.2	142.4	153.1
Egypt	213.4	168.4	117.5	111.0	122.8

[a] Damietta was not included in Lower Egypt in 1946-47.
[b] Not a separate governorate at that date.

In 1975-76, urban infant mortality was lower than rural in every governorate except Kalyubia and Ismailia. Much of the urban population of Kalyubia resides in the Cairo metropolitan area; the urban IMR in Kalyubia is slightly higher than IMR in urban Giza (also part of the Cairo metropolitan area); the rate in urban Giza in turn slightly exceeds the rate in Cairo. The rural part of Kalyubia is in Lower Egypt. The rural areas of the other governorates in Lower Egypt have lower infant mortality rates than Cairo. In other words, the fact that Kalyubia's urban population consists mostly of the highest infant mortality population in the metropolitan area may account for the higher urban than rural infant mortality rate in this governorate.

There are three distinct geographic clusters of infant mortality rates in 1975-76 in the rural populations of the governorates. In six governorates near the Mediterranean (Ismailia, Damietta, Dakahlia, Kafr-el-Sheik, Behera, and Gharbia) the rural infant mortality rate is less than 100 (per thousand live births); in four governorates in the delta or along the Nile near Cairo (Sharkia, Menoufia, Kalyubia, and Giza) rural IMR lies between 109 and 127; in the seven governorates farther up the Nile (Souhag, Aswan, Fayoum, Assyiut, Kena, Beni-Suef, and Minya) the rural infant mortality rate lies between 138 and 168.

ADDITIONAL MEASURES OF FERTILITY FOR EGYPT AND FOR GEOGRAPHIC SUBDIVISIONS, 1937-76

The crude birth rate has well-known limitations as a measure of trends and differences in fertility, the most troublesome limitation being the strong influence of the composition of the population by age and sex. For example, an area may have a high birth rate because young married couples have migrated there. Also, within a given population the birth rate falls when mortality is reduced, even if women of childbearing age have births at an undiminished rate, because a reduction in mortality typically reduces the ratio of the number of women aged 15 to 50 to the total population. In portraying changes in fertility in Egypt it is therefore convenient to employ measures of fertility that are partly or wholly independent of differences in age composition. It is possible to construct such measures and indices for years in which there was a census that provides information on the composition of the population by age, sex and marital status.

The fertility measures we have employed are: (1) the general fertility rate, defined as the rate at which women aged 15 to 50 bear children. It equals the crude birth rate divided by the ratio of the number of women aged 15-50 to the total population; (2) the total fertility rate, defined as the number of children that would be born per woman in a hypothetical cohort subject, from age 15 to 50, to the age-specific rates of childbearing in the population in question; and (3) three indexes of fertility (I_f, I_g, and I_m) that measure overall fertility, marital fertility, and the proportion married among women of childbearing age. The index of overall fertility, I_f, is the ratio of the number of births occurring in a population to the maximum number that might occur, if women at each age experienced the highest rates of marital childbearing on reliable record for a population. The index of marital fertility, I_g, is the ratio of the number of births occurring to married women to the maximum number married women might have if subject to maximal fertility rates at each age. The index of proportion married, I_m, is a fertility-weighted index that measures the contribution of marital status to the attainment of maximal overall fertility in a population in which childbearing occurs only among married women (as is true in Egypt). The indexes strictly of fertility (I_f and I_g) lie between 0 and 1--a value of 1 would imply attainment of maximal fertility, and 0 implies no births at all. The index of marriage (I_m) falls within the same range: it is 1 if all women 15 to 50 are married, and 0 if all are single, widowed, or divorced. Because in no recorded instances does early and universal marriage coincide with maximal marital fertility, the highest observed values of I_f are about 0.70. The highest observed value of I_g is about 1.0 and of I_m, slightly above 0.90. When fertility among the non-married is negligible, the three indexes are related by the identity $I_f = I_m \cdot I_g$. Overall fertility is thus factored into two components: the proportion married and marital fertility (see Coale, 1965 and 1970, for a fuller definition of the indexes).

All of these measures and indexes are presented in Table 4 for Egypt at the time of the censuses of 1937, 1947, 1960, and 1976, and for selected geographic subdivisions at the three later time periods. No data are presented on the frontier areas, and, except in some of the methodological comparisons, data for Suez and Port Said are also omitted. For the period before 1961 this exclusion applies to the urban governorates other than Cairo and Alexandria.

For Egypt as a whole, the more refined measures of fertility for women of childbearing age (the general fertility rate, the total fertility rate, and I_f) follow a somewhat different course than does the crude birth rate--the reason for the difference being the change in age composition that altered the proportion of women 15-50 within the total population. From 1937 to

1947 the change was modest (probably within the margin of error caused by the changing degree of age misstatement), but between 1947 and 1960 the proportion of women of childbearing age fell by nearly 10 percent as declining infant mortality increased the proportion of children in the population. Still greater reductions in infant mortality after 1960 were offset by reductions in fertility; women 15-50 were a slightly higher fraction of the population in 1976 than in 1960.

The estimates of the general fertility rate, total fertility rate and I_f for Egypt in 1960 show a rise of 6 to 8 percent over the levels estimated for 1947. Because of the margin of error in our estimation of completeness of enumeration, the true extent of the increase is uncertain, but since we have chosen conservative estimates of the extent of underregistration in 1960, there is little doubt that an increase occurred. The increase is the joint result of a slight rise in both the proportion married (I_m increased by 2.6 percent), and marital fertility (I_g increased by 3.2 percent). Similar increases in marital fertility in a period before the widespread adoption of contraception or abortion have been noted in a number of developing countries (Coale et al., 1979; Coale et al., 1980).

Influence of Marriage Trends on Fertility

From 1960 to 1976, overall fertility fell by 18 percent. The reduction in the index of the proportion married was greater than the reduction in marital fertility; I_m fell by 12 percent, while I_g fell by 6.3 percent. The reduction in I_m must have been the result of a marked change after 1960 in the frequency of first marriages among younger women. Table 5 shows the proportion single among women at ages 15-19 and 20-24 from 1937 to 1976, together with the singulate mean age at first marriage (SMAM), calculated from proportions single from age 15 to 50 in each census. (The singulate mean age at first marriage is the average age at first marriage that would be experienced by a hypothetical group of persons if, in moving from age 15 to 50, the group had the proportions single observed in the census.) Note the slight changes in proportions single and in SMAM from 1937 to 1960, and the significant changes between 1960 and 1976.

In Figure 3 a measure of what might be called the intensity of first marriages is shown from 1964 to 1976.

TABLE 5 Proportion of Women Single at Ages 15-19 and 20-24 and Singulate Mean Age at Marriage (SMAM) for Women in 1937, 1947, 1960, and 1976: Egypt

Proportion Single	1937	1947	1960	1976
15-19	.752	.736[a]	.746[b]	.833
20-24	.197[c]	.200[b]	.229	.389
SMAM	20.04	20.12	20.26	21.65

[a] After adjustment for "unknown". "Unknown" assumed to be 0.5 percent of the total; other "unknown" taken as single.

[b] After adjustment for "unknown": of 1,040,286 women aged 15-19, 776,500 were estimated to be single; 2,300 were assumed to belong in the category "unknown."

[c] Estimated from marital status distribution by ten-year age groups.

This measure is the number of first marriages divided by the approximate number of women at the mean age of first marriage--about age 20 in Egypt. The number at age 20 is approximated by the average number of women in a 20-year age-span centered on age 20--one-twentieth of the number from 10 to 29. When almost all women marry, generally the case in Egypt, the "intensity" of first marriages should average slightly below 1.0.

A rise in mean age at first marriage of one year means, crudely, that one calendar year's first marriages are missing over the period during which the change in mean age takes place. (This relation can be understood by picturing a hypothetical population in which all first marriages take place at the mean age, say 20. In year t, the usual first marriages take place with brides aged 20. In year t + 1, the mean age moves up to 21, but no marriages take place until t + 2, since the cohort aged 21 in t + 1 has already married at 20. From t + 2 on, marriages occur in normal numbers at the older age, but one year's marriages have been lost.) Thus between 1960 and 1976, when SMAM increased by 1.4 years, the rate of first marriage must have decreased, as can be seen in the low points from 1965 to 1969 in Figure 3. It seems probable that the low point in the birth rate sequence in the early 1970s (seen in Table 2 and Figure 2) reflected this cumulative deficit in the number of recently married couples. Were it possible to calculate I_m for 1970, it

TABLE 4 Measures and Indexes of Fertility, 1937, 1947, 1960, 1976: Egypt

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1936-37							
Egypt	48.2	198.8	6.45	.520	.679	.766	.243
1946-47							
Egypt	47.9	191.7	6.31	.509	.694	.734	.250
Cairo and Alexandria	47.5	188.0	6.04	.487	.711	.684	.253
Rest of Egypt	48.0	192.7	6.36	.513	.690	.744	.249
1959-60							
Egypt	46.3	204.5	6.71	.541	.716	.753	.226
Cairo and Alexandria	41.3	184.7	5.90	.476	.667	.703	.224
Lower Egypt	46.2	208.1	6.88	.555	.726	.764	.222
Upper Egypt	47.8	205.9	6.78	.547	.714	.767	.232
1975-76							
Egypt	39.2	167.3	5.52	.445	.671	.663	.234
Cairo and Alexandria	31.5	121.2	3.89	.314	.535	.587	.260
Lower Egypt	38.6	169.6	5.70	.460	.692	.656	.228
Rural	39.3	177.9	5.99	.483	.703	.687	.221
Urban	36.6	149.1	5.01	.404	.659	.614	.246
Upper Egypt	44.1	193.7	6.40	.516	.725	.712	.228
Rural	45.5	204.5	6.81	.549	.739	.743	.223
Urban	40.7	169.7	5.56	.448	.692	.648	.240

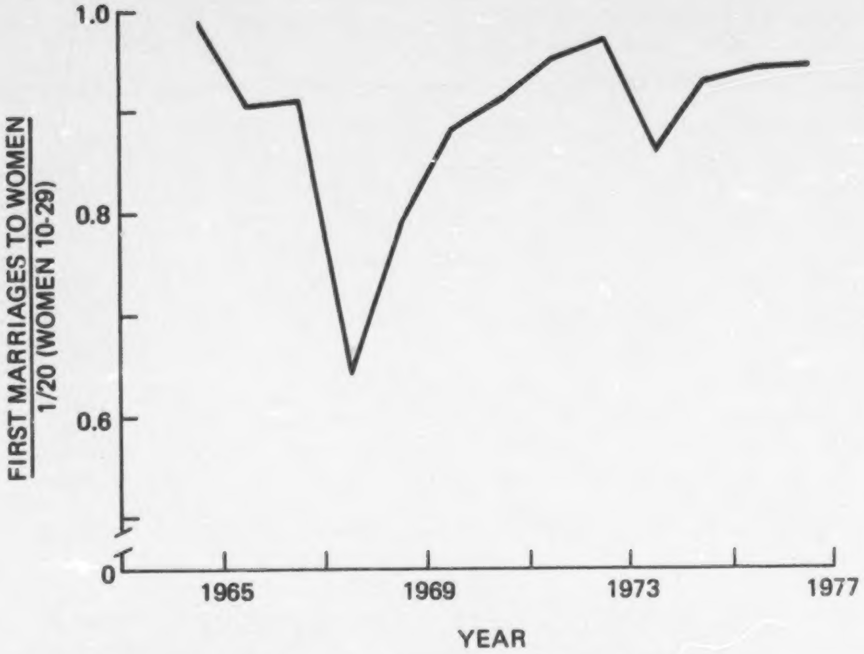


FIGURE 3 Intensity of First Marriages Among Women, 1964-76: Egypt

would doubtless have been still lower than in 1976. The recovery of the birth rate after 1972 was to a large extent, if not wholly, a consequence of partial recovery from a greatly reduced fraction married among younger women of childbearing age.

The regional measures of fertility in Table 4 show that in 1947 and 1960 Cairo and Alexandria had lower proportions married than the rest of the country; I_m there was about 92 percent of I_m in the remainder of Egypt. In 1947 marital fertility in the metropolitan areas was at least as high as in the rest of Egypt (an I_g of 0.711 compared to 0.690), but by 1960 marital fertility in Cairo and Alexandria was only about 93 percent as high as in Upper and Lower Egypt combined. All three indexes for the latter two regions were very nearly the same--indeed indistinguishable given the margin of error in adjusting the original data.

Between 1960 and 1976, the decline in overall fertility and in both of its components (marital fertility and proportions married) was greatest for Cairo and Alexandria. In 1976 urban Lower Egypt reached an

I_m almost as low as Cairo and Alexandria, but its I_g was substantially higher than in the two major cities. Urban Upper Egypt had a lower I_m and I_g than rural Upper Egypt, but not much lower than rural Lower Egypt. Note that in 1976 the I_g in rural Upper Egypt was virtually the same as that in Upper Egypt in 1960, and I_m was only slightly lower.

In sum, we can see that the reduction in fertility in Egypt has been caused both by later marriage (a reduction in the effective incidence of nuptiality) and by a fall in marital fertility. Lower proportions married characterized Cairo and Alexandria as early as 1947. Between 1960 and 1976 the reduction in I_m in these cities was particularly sharp compared to other areas, although other urban areas in Lower Egypt, and to some extent in Upper Egypt, had also attained low I_m. The decline in marital fertility was large (20 percent between 1960 and 1976) only in the large cities. In Lower Egypt the decline in marital fertility was about 5 percent, and in Upper Egypt there was a negligible rise of 1.3 percent.

Voluntary Control of Marital Fertility

As a final comment on recent fertility in Egypt, we note evidence of the effect of voluntary control of marital fertility in the major regions, revealed by data collected in the National Fertility Survey conducted in 1974 and 1975. The survey collected retrospective fertility histories from a sample of more than 12,000 currently married women. Mahmoud S. A. Issa (1980) has calculated age-specific marital fertility rates for each region from data on births during the preceding five years to women who were continuously married during the five years before the survey. He has also calculated an index of the degree of departure of the age structure of marital fertility from the pattern typical of populations in which there is no voluntary control of marital fertility (Coale, 1971; Coale and Trussell, 1974, 1978). This index (m) is zero when marital fertility follows the typical pattern of "natural" fertility; it reaches values of 2.0 or more in populations in which the majority of couples use contraceptives or abortion to limit the total number of births to a very small number.

In Figure 4, the value of m (the degree of control indicated by the age structure, not the level, of marital

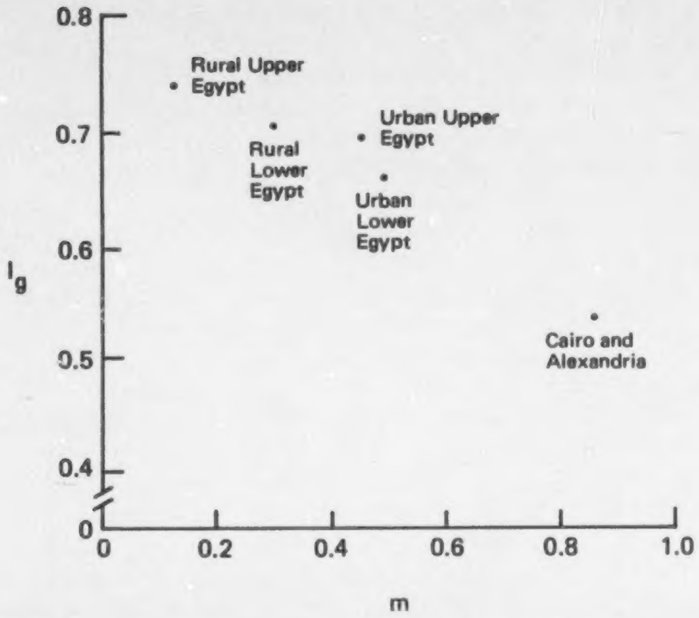


FIGURE 4 Comparison of the Index of Voluntary Control of Marital Fertility (m) and the Index of Marital Fertility (I_g), Major Regions, 1975-76: Egypt

fertility) is compared with our calculations of I_g. The close agreement gains significance from the complete independence of the two measures. One measure (I_g) is based on registered births corrected for underregistration, and the census count of married women. The other measure (m) is based on the rate at which marital fertility falls with age of women, as revealed in retrospective fertility histories collected in a sample survey. The story is the same: marital fertility is lowest (and most strongly controlled) in Cairo and Alexandria, and progressively higher (and less controlled) in urban Lower Egypt, urban Upper Egypt, rural Lower Egypt, and rural Upper Egypt. In rural Upper Egypt, m has a value (0.125) within a range of departure from zero of ± 0.20 found in populations in which voluntary control appears to be absent.

Preliminary findings from two recent surveys also substantiate regional variation in the control of marital fertility. Reported contraceptive prevalence rates (the proportion of currently married women aged 15-49 using contraception) in 1979 and 1980 are listed below (Sayed, 1981; Egypt [CAPMAS], 1981):

	Contraceptive Prevalence Rates		
	Total Urban (percent)	Total Rural (percent)	Total Egypt (percent)
Rural Fertility Survey 1979		12	
Egyptian Fertility Survey 1980	40	15	24

Prevalence rates follow the same regional pattern as the m values based on the 1974-75 survey. Marital fertility control, reported in the 1980 Egyptian Fertility Survey, is greatest in Cairo and Alexandria (43 percent prevalence), only slightly less in urban Lower Egypt (41 percent), and progressively less in urban Upper Egypt (33 percent), rural Lower Egypt (18 percent), and rural Upper Egypt (4 percent). The principal method of contraception in Egypt is the pill, accounting for about two thirds of total prevalence in 1980.

3 Sources of Data

Under ideal conditions of availability and accuracy of demographic data, levels and trends of fertility and mortality are calculated from a combination of registered births classified by age of mother, registered deaths classified by age of the decedent, and data on the number of persons by age and sex derived from a series of accurate population censuses. In most developing countries, demographic data of the ideal sort do not exist. At best, the official figures can be used only after correcting for omissions, misstatement of age, and the like. More often, registration of births and deaths is so meager that levels and trends must be estimated by indirect procedures from data derived solely from censuses and demographic surveys.

Demographic data in Egypt are unusually rich, although imperfectly accurate. The data include a series of 10 censuses (the first in 1882) among which have been used, in some degree, those of 1927, 1937, 1947, 1960, and 1976. These censuses provide a count of persons classified by their reported age, by sex, and by marital status. Table 6 lists the total population, by sex, enumerated in these five censuses. Some of the censuses list the number of children ever born (1947, 1960, and 1976), and the number of living children (1947 and 1976) for women in different intervals of age and of marriage duration.

A feature of Egyptian population data even more unusual for a developing country than a long series of censuses is the existence of recorded information on registered deaths classified by age and sex, registered births (classified by age and duration of the marriage of the mother, as well as certain characteristics of the father), registered marriages (classified in detail

TABLE 6 Enumerated Population, by Sex, in the 1927-76 Censuses: Egypt

	Population (thousands)		
Census	Total	Males	Females
1927	14,178	7,058	7,120
1937	15,921	7,967	7,954
1947	18,967	9,392	9,575
1960	26,085	13,118	12,967
1976	36,656	18,699	17,957

Source: Egypt [CAPMAS] (1979:10).

concerning age and previous marital status of bride and groom), and registered divorces (classified by duration of marriage and other categories).

In addition to population censuses and registration of vital statistics, there have been a number of special surveys that have collected primary data about fertility, mortality, or both from samples of the Egyptian population (see Figure 5). Two of these surveys covered large nationwide samples--the National Fertility Survey conducted in 1974 and 1975, and a survey conducted in 1980 in collaboration with the World Fertility Survey. A second large survey in 1979 under the auspices of the National Family Planning Board covered a sample of the rural population only. Data from the surveys taken in 1979 and 1980 were not tabulated and processed in time for inclusion in this report, but we have used data from the 1974-75 National Fertility Survey as a check on our regional estimates of infant mortality and marital fertility, estimates derived from a combination of census and registration data.

Until 1961, registration of births and deaths was the responsibility of medical officials within those areas in which there were Health Bureaus, and of tax collectors in the remainder of the country. Special information (order of birth, age and duration of marriage of the mother, and cause of death) was recorded only in the Health Bureau areas. After a reorganization of vital statistics registration in the 1960s, uniform registration

FIGURE 5 List of Surveys Collecting Primary Data about Fertility, Mortality, or Both: Egypt

1965-1966	Rural Vital Rates Survey in Lower Egypt
1966	Census of Population (tabulated on a sample basis)
1974-1975	The National Fertility Sample Survey Project in Egypt
1974-1975	The Vital Events Sample Survey, 1974-1975
1979	National Family Planning Board Rural Population Survey
1980	Egyptian Fertility Survey (EFS)--associated with the World Fertility Survey program

procedures were followed in recording vital events in all areas, with or without Health Bureaus.

The existence of an extended series of censuses and the registration of births, deaths, marriages, and divorces do not imply that Egyptian fertility, mortality, and nuptiality can be delineated readily by an appropriate combination of numbers of registered events and numbers of persons (or person years) derived from censuses to obtain standard rates and measures. Completeness of coverage of the censuses has been imperfect in varying degrees, both for the total population and for persons of each sex at different ages. There is persistent evidence revealing incompleteness of registration of births and deaths in Egypt; for example, birth and death rates calculated from registered events in areas served by Health Bureaus were consistently higher than those in other parts of the same governorates.

Another reason why indexes of fertility and mortality cannot be calculated by routine procedures is the inaccurate recording of age, duration of marriage, and other information, such as order of births, both in censuses and in the registration of vital events. It is apparent that a large proportion of persons and a large proportion of deaths are recorded in wrong five-year age intervals, that first and second births are recorded at higher than the correct order, and that the duration of a mother's marriage at the birth of a child is often overstated for many births (in some years fewer than a hundred births in all Egypt are reported as having occurred to women married less than a year). It is also clear that parity (number of live births ever experienced) is understated, at least by older women.

The existence of unusually extensive, although imprecise, information has dictated the strategy employed in constructing our principal estimates. The general approach has been to use interrelations among data taken from censuses and from registers to estimate the extent of errors in each, and to base estimates of fertility and mortality on data that have been adjusted for the biases that are detected.

4 Methods of Estimation

The discussion of methods of estimation in the next few pages of this report is limited to a description and brief justification of the broad strategy followed. More detailed explanations are presented in a series of appendixes. As intimated in the preceding section on Egyptian data, the strategy of estimation entailed using information from censuses to estimate the extent of errors in the registration of events. Numbers of registered births, infant deaths, and deaths beyond infancy were then adjusted for the errors thus estimated. Underregistration of births and infant deaths was determined at particular dates (dates just before the censuses containing the relevant information). At these dates the estimated extent of underregistration was determined separately for different segments of Egypt, such as the metropolitan populations of Cairo and Alexandria, populations residing in areas having Health Bureaus, and populations residing in areas without Health Bureaus.

INFANT MORTALITY

Perhaps the best known and most robust technique of indirect estimation of vital rates from census data is the estimation of mortality in early childhood from reports in a census or survey of the proportion dead among the total number of children ever born to young mothers. The original procedure was invented by William Brass; alternative versions have been developed by Sullivan and Trussell. Specifically, the proportion who have died of all children borne by women 20-24 can be converted into a useful estimate of what fraction of the newly born die before the second anniversary of their birth, and which can then be converted into a slightly less accurate estimate of the fraction who die before the first anniversary, the infant mortality rate.

The appropriate questions (on number of children ever born, and number still surviving) were asked in the censuses of 1947 and 1976; and the answers were tabulated both by age and duration of marriage of the mother. The information on child survival derived from these two censuses was the basis for estimates of how nearly correct the infant mortality rates recorded for each governorate in 1946-47 and 1975-76 were.

For 1946-47, the quality of two rates of infant mortality in each governorate was estimated: the infant mortality rate in the Health Bureau areas in each governorate, and the infant mortality rate in the entire governorate. In all instances, the infant mortality rate (IMR) recorded in the Health Bureau areas was greater than the rate recorded for the whole governorate (reflecting better registration in the Health Bureaus, not genuinely higher mortality). To obtain corrected infant mortality rates for 1927 to 1961 (the era of the Health Bureaus), it was assumed that the adjustment factor necessary to convert the IMR registered in the Health Bureaus in a governorate into the IMR calculated for the entire governorate for 1946-47 from 1947 census data on child survival was the appropriate adjustment factor to convert the Health Bureau IMR in other years to the proper IMR for the governorate in question. This assumption makes allowance for the increasing proportion of the population in Health Bureau areas, an increase that resulted from creation of additional Health Bureaus, expansion of boundaries, and migration. Between 1947 and 1960, the proportion of the population in Health Bureau areas rose from 38 to 47 percent, and increased in every governorate except the wholly urban governorates, which had no non-Health Bureau segments.

For 1975-76, the quality of recorded infant mortality rates in the rural and urban sectors of each governorate was estimated separately on the basis of rural and urban data on child survival in the 1976 census. In all but two governorates urban infant mortality was better recorded than rural. (In the two exceptional instances, both urban and rural registrations were estimated to be at least 97 percent complete.) Registration was found to be more nearly complete in Lower than in Upper Egypt.

A new uniform system of administering vital statistics was instituted in 1962, and separate tabulations of vital statistics for Health Bureau areas were discontinued. Through 1961, the estimated IMR for Egypt is the weighted sum of the estimates for the governorates, and the estimate for each governorate is the rate for the Health Bureau areas within the governorate corrected by the factor established for 1946-47. From 1962 to 1976, the estimated IMR for Egypt is the weighted sum of the IMR for Cairo and Alexandria, rural Lower Egypt, urban Lower Egypt, rural Upper Egypt, and urban Upper Egypt--each adjusted for the completeness of registration determined for each sector in 1975-76. Thus the basis for adjusting IMR changes from 1961 to 1962. The discontinuity in adjustment serves to reduce (and almost eliminate) a sudden increase in the unadjusted registered rate from 1961 to 1962. (The registered rate rises by 22 percent, the adjusted rate by only 3 percent.) Evidently, registration of infant mortality was more nearly complete in 1962 under the new registration procedures than in 1961 under the old. (See Appendix A for a more complete discussion.)

FERTILITY

Completeness of birth registration in each governorate was estimated for the years prior to the 1947 and 1976 censuses by the classic procedure of the reverse projection of the enumerated child population, in this instance at ages between exact age 1 and exact age 5. The two obstacles to estimation of the true number of births by reverse projection of the number of children counted in a census are (1) the difficulty of determining the correct survival factor when deaths are not correctly registered; and (2) the inaccuracy with which numbers of children are recorded in censuses because of omission and misreporting of age.

The first problem was addressed by basing the reverse survival factors ($4 \cdot \ell_0 / {}_4L_1$ in life table terminology) on recorded infant mortality for the appropriate years, after adjustment for the estimated degree of underregistration. (The relation of ${}_4L_1$ to corrected average infant mortality was taken from the "West" family of Coale-Demeny model life tables.)

The second problem is more intractable, since misstatement of age and possible differential omission of young children are undeniable features of Egyptian censuses. For example, the number of persons recorded as 10-14 in 1947 is 5 percent greater than the number recorded as less than 5 in 1937, despite the very high mortality to which children were then subject. This more difficult problem was addressed by introducing two tactics designed to minimize the effect of the under-enumeration of young children. The first tactic was to select an age interval in which the undercount is less severe than in more conventional intervals (under 1 or under 5) and the second was to adjust the recorded number at ages 1 to 5 in every governorate by a factor that would equate reverse-projected births with registered births in Cairo and Alexandria. The number of children under 1 year of age is very frequently understated in censuses, because of two factors that cannot generally be disentangled-- overstatement of age of infants (including especially those in the last few months of their first year) and omission of infants. The number of children under 5 years of age is also very frequently understated because of analogous factors--overstatement of age of those approaching 5, and omission, perhaps most frequently of young infants. The number of children counted as 1 to 5 thus gains from overstatement of the age of infants, and loses from overstatement of age of 3- and 4-year-olds, and is not affected by omission of infants under 1. *A priori*, then, the number of children in the segment from 1 to 5 should be less severely undercounted than either the number under 1 or the number under 5.

It is unlikely, merely because the recorded number is affected by offsetting biases, that the count of children aged 1 to 5 in each Egyptian census is a suitable foundation for determining with any exactness the number of births one to five years before the census. The correctness of the count of children aged 1 to 5 in each census was judged by the match in Cairo and Alexandria between the reverse projection and the number of births registered in the appropriate pre-censal years, on the assumption that registration of births was approximately complete in the two large cities. A correction was applied (if needed) to the enumerated population aged 1 to 5 in Cairo and Alexandria such that this population projected back to birth would agree with the number of births registered in those cities one to five years before the census. The same proportionate correction was then applied to the enumerated population aged 1 to 5 in the same census in all other governorates. In other words, the population aged 1 to 5 in each governorate was adjusted by the factor appropriate to the metropolitan populations, on the assumption that births in the latter were fully registered.

There are many reasons for believing that registration is relatively complete in the two major cities. Both have been fully within Health Bureau administration as far back as our estimates go. The sex ratio at birth, consistently too masculine (compared to general experience) in Egyptian registered births, is highest (most exaggerated) in areas not covered by Health Bureaus, second in Health Bureaus in other than the urban governorates, and is lowest (within the normal range) in Cairo and Alexandria. Finally, the level of the infant mortality rate in the large cities, relative to infant mortality derived from child survival (in the 1940s and the 1970s) is a strong indication of good registration. Complete registration of infant mortality is more difficult to achieve than complete birth registration; if infant deaths are well recorded, births are very likely well recorded also.

The reverse projection to birth of the population aged 1 to 5 in 1976 matched the number of registered births in 1972 to 1975 in Cairo and Alexandria within less than one half of one percent; hence no adjustment was made to the enumerated child population in any of the governorates. The corresponding reverse projection for the two cities in 1947 was 94.3 percent of registered births; hence the enumerated population at ages 1 to 5 in every governorate was increased by 1/.943 before reverse projection was carried out. Completeness of registration of births and infant mortality in the 1940s and 1970s for the two large cities, for Upper Egypt, and Lower Egypt are listed in Table 7. At the later period separate figures are given for the rural and urban sectors of Upper and Lower Egypt. Note the generally much greater completeness of registration of births than of infant deaths, the progression of completeness from most complete in the metropolises to least complete in Upper Egypt, and the greater completeness in urban areas than in rural areas in the 1970s.

The estimated completeness of registration of births in each governorate in 1942-45 and 1972-75 was the basis for approximate estimates of completeness by governorate in 1960, and for completeness in all Egypt for 1927 to 1947 and for 1960 to 1976. (Because of extensive and

TABLE 7 Estimated Completeness of Registration of Births and Infant Mortality, 1940s and 1970s: Egypt

Region	Births	Infant Mortality
Part A. 1940s	(mid 1942 - mid 1946)	(1946-47)
Egypt	.890	.837
Cairo and Alexandria	1.001	1.106[a]
Lower Egypt	.929	.791[a]
Upper Egypt	.804	.708[a]
Part B. 1970s	(1972-75)	(1975-76)
Egypt	.964	.753
Cairo and Alexandria	1.004	.984
Lower Egypt	.997	.807
Rural	.997	.780
Urban	.996	.896
Upper Egypt	.911	.625
Rural	.888	.537
Urban	.975	.879

[a] Completeness of infant mortality in health bureau areas.

diverse evidence of especially poor registration during the 1950s, quantitative estimates of the extent of underregistration from year to year were not attempted for 1948 to 1959.)

El-Badry (1965) has also estimated the birth rate for all Egypt for the period one to five years before the 1947 census. Our estimate of the birth rate, adjusted for the calculated degree of underenumeration, agrees within a small fraction of 1 percent with El-Badry's estimate. Therefore, El-Badry's estimates of the Egyptian birth rate for 1927 to 1947 have been adopted. To make his estimates, El-Badry accepted the registered births in the urban governorates (100 percent Health Bureau) and in the urban Health Bureau areas in other governorates as correct. He also assumed that the birth rate in the entire rural population of the governorate was the same as that in the rural Health Bureau areas of that governorate. The agreement of El-Badry's estimate of Egypt's birth rate with that obtained by reverse projection of the population aged 1 to 5 (adjusted for underenumeration) implies that registration of births in the Health Bureaus was essentially complete.

Completeness of birth registration in 1956-59 was calculated for each governorate by reverse projection of the population aged 1 to 5 in the 1960 census, with the intention of finding an adjustment that could be applied to registered births for 1960 and 1961, to facilitate construction of fertility measures and indexes by governorate and region as of the 1960 census. Because of extensive evidence of particularly poor registration in the 1950s (including 1956 and 1957), it is apparent that the average underregistration for 1956 to 1959 was much greater, especially in some governorates, than in 1960 or 1961. It was therefore decided--for want of a better solution--to estimate the completeness of birth registration in each governorate in 1960-61 as the arithmetic mean of the completeness estimated for 1942-46 and 1972-75. For 1962 to 1972, completeness of birth registration for Egypt as a whole was assumed to change linearly from the estimated 0.927 for 1960-61 to 0.964 for 1972-75. (See Appendix B for additional discussion.)

ADULT MORTALITY

To depict changes in mortality since 1927, we have constructed separate annual approximations of mortality up to age 5 and above age 5, for males and females. Mortality under age 5 in each calendar year was represented by a segment of a "West" model life table for each sex--the segment from birth to age 5. The appropriate model life table was determined by finding the mortality level in the "West" family at which infant mortality for the two sexes combined matched the adjusted infant mortality rate that had been calculated for the year in question.

Estimation of mortality over age 5 was accomplished, as were our other estimates, by combining information on registered events (in this instance the number of deaths to persons over 10 classified by age and sex) with information drawn from censuses (in this instance the number of persons at census dates, classified by age and sex, and interpolated in other years to approximate the numbers that might have been counted had censuses been taken annually). The method is an adaptation of a new procedure developed by Preston and refined by others (Preston et al., 1980). The procedure is based on the equality in a stable population (and near equality in a population in which mortality has recently declined) of the number of persons at each age and the sum of the deaths at all higher ages, after multiplication of the deaths at each higher age by a suitable exponential factor based on the population's estimated rate of increase. Because of this equality, it is possible to calculate the number of persons above age 10, age 15, age 20, etc., that are implied by the recorded number of deaths (and the rate of increase). If deaths are fully registered, the calculated number above each age very nearly matches the number recorded in a census, or interpolated for a non-census year; if deaths are not fully registered, the ratio of the calculated number to the recorded number is an estimate of the completeness of death registration.

In Egypt the application of this procedure was complicated by the obvious severe overstatement of the number of deaths at very advanced ages. It is clear that the excess numbers of reported deaths at ages above 70 and 80 are at the expense of understated numbers at earlier ages from 10 to 70. Our inference, which we are confident is correct, is that deaths of persons whose age is unknown are reported at the ages above 70 (mostly above 80, in fact).

Because of this feature of the registration of deaths in Egypt, the estimation of the mortality schedule above age 5 required several steps. First, the true proportion of deaths above age 70 was approximated by finding the proportion of deaths over 70 in a model stable population matching the population of the year in question in growth rate (of the population over 10) and in broad structure (namely, the ratio of persons aged 10 to 50 to persons 10 and over). Deaths over 70 in excess of the proportion thus estimated were redistributed, being added pro rata to deaths at ages 10 to 70. Second, completeness of death registration among deaths over age 10 was calculated by comparing the expected population, derived from the number of deaths (so redistributed) and the rate of increase, and the population derived from census counts. It was concluded that from 1936 to 1946, male deaths above age 10 were underregistered by about 5 percent, and female deaths by about 20 percent. From 1947 until 1960, death registration deteriorated, with completeness in the mid-1950s falling below 60 percent for males, and below 50 percent for females but recovering after 1960 to about 100 percent for males, and 85 percent for females. Third, the death rate over age 10 for each sex was recalculated, allowing for the estimated extent of underregistration. Finally, a "South" model life table producing the estimated death rate over age 10 in a stable population with the estimated rate of increase was selected. The mortality schedule above age 5, and the expectation of life at age 5 (for each sex) in this model life table were accepted as approximately appropriate. Another possibility would have been to adjust the recorded number of deaths (after reallocation of deaths from ages over 70 to ages 10 to 70) for the estimated degree of omission, and calculate an age-specific mortality schedule. Expectation of life at age 5 derived in this alternative way is very little different, but certain features resulting from age misreporting are probably farther from the true schedule than is the model life table. (See Appendix C for a more detailed discussion.)

PROJECTING THE POPULATION

A population projection was employed to reconstitute the Egyptian population incorporating an initial population that reallocated the population enumerated in 1927 to a stable age distribution. The stable population combined the male and female life tables we constructed for the period with an estimated birth rate based on registered births adjusted by the average factor employed in the 1930s. In each subsequent five-year period, a life table was employed that incorporated average child mortality from estimated IMRs, and average mortality over age 5 from corrected death rates over age 10 and the rate of increase. In each quinquennium, the number of births introduced to determine the population less than 5 was the adjusted number described in the "Fertility" section above. The projection is discussed in detail in Appendix D.

The projection produces constructed populations at the later census dates agreeing closely with the total number enumerated in 1947 and 1960. Differences between the projected and enumerated totals arise for 1937, when the census appears to have undercounted the population by some 4 percent more than other censuses, and for 1976, when much of the difference between count and projection is explained by a large number of Egyptians abroad. The projected populations also agree in age structure with the enumerated populations (except for consistent age- and sex-specific biases in the censuses). This agreement does not prove that the estimates of fertility and mortality are correct (there could be offsetting biases in estimating fertility and child mortality that would yield a projection consistent with the censuses), but it does strongly support the estimated trends.

Appendix A
Estimation of Infant Mortality

Chapter 4, devoted to methods of estimation, describes the use of data from the 1947 and 1976 censuses on child survival to estimate the degree of underregistration of infant mortality. This appendix provides more details on the measurement of underregistration of infant mortality and the construction of corrected infant mortality rates.

THE BRASS ESTIMATION PROCEDURE

It is fortunate that the censuses of 1947 and 1976 included questions asked of every ever-married woman concerning the number of children she had borne in her lifetime and the number of these children still living. In 1947 the only conclusion about mortality that could be inferred from such data was the obvious qualitative inference that a lower proportion surviving among the children ever born to women at any particular age or duration of marriage implied higher mortality rates in infancy and childhood in the population. By the 1960s, Brass had invented a procedure to go beyond mere qualitative observation and to determine from these data sound numerical estimates of the fraction of children who die and the fraction who survive between birth and specified precise early anniversaries of birth. If p(x) is the proportion that survives to age x, and q(x) the proportion that dies before age x, it is possible to estimate q(2), q(3), and q(5)--and their complements p(2), etc.--by the methods that Brass devised, methods subsequently refined by Sullivan and Trussell (Brass and Coale, 1968; Sullivan, 1972; and Trussell, 1975).

We have made use of the generally most trustworthy of the Brass-style estimates, that of the proportion dying before exact age 2, [q(2)]; q(2) is derived from the proportion dead among children ever born to women in the age interval 20-24 or in the duration of marriage interval less than five years. The rationale of the Brass estimation procedure is as follows:

(1) The proportion dead among children born to women in a particular interval of marriage duration or age depends on two factors: the mortality schedule to which the children have been subject and the distribution of births through time in the interval prior to the census survey. The higher the age-specific death rates the higher the proportion dead; the greater the concentration of births in the recent past (i.e., the younger the children would be in the absence of mortality), the lower is the proportion dead.

(2) The approximate distribution by year of birth of the births the women have had in the years preceding the census can be inferred from the sequence of average parities (average number of children ever born) for women in the age intervals 15-19, 20-24, and 25-29 or in the marriage-duration intervals less than 5, 5-9, and 10-14 years. Armed with approximate knowledge of the time distribution of births, one can estimate the level of mortality rates to which the children have been subject, a level expressible as the proportion dying before the second birthday when information on child survival is taken from women in the age interval 20-24 or in the duration interval 0-4.

For our estimates, we used Trussell's version of the calculation procedures; the result of using the Brass or Sullivan versions is to modify the estimates only very slightly. The estimation of mortality in the early segment of life by what is generally known as the Brass procedures has proven reliable in applications to data from different populations in both more developed and less developed parts of the world (United Nations, Department of Economic and Social Affairs [Manual IV], 1967:36). However, even with perfectly accurate data there is some uncertainty about such estimates because information about the age pattern of mortality to which the younger population is subject may be lacking, because infant mortality among children born to young mothers differs from infant mortality among children born to older mothers, because changes in infant mortality raise difficult questions about the period to which the estimates pertain, and because recent changes in fertility may make the estimation of the past time pattern of births from the sequence of average parities in the census imprecise. Additional problems arise from the possible omission of some dead children in responding to these questions, and from misreporting of age and duration of marriage in the censuses of many developing countries, including Egypt.

In Egypt the estimates of q(2) derived from data on child survival classified by age and classified by duration of marriage do not agree, as ideally they should. In each of the three panels of Figure A-1 the values of q(2) derived from the proportion dead among children ever born reported by women aged 20-24 (age-based estimates) are compared with the values of q(2) derived from the proportion dead reported by women of marriage duration less than five years (duration-based estimates). In the first panel, the two sets of estimates are compared for the governorates of Egypt in 1947; in the second panel, for the urban population of the governorates in 1976; and in the third panel, for the rural population of the governorates in 1976. In all three instances there is a very strong correlation between the two sets of estimates, an agreement that is scarcely surprising since the underlying data are essentially two different tabulations of responses recorded from virtually the same women (most women in the first five years of marriage are 20-24 years of age). In the rural population in 1976, the two sets of estimates are in almost perfect agreement, but in the urban population in 1976, and the combined urban and rural populations in 1947, the age-based estimates are higher, with only one exception.

Derived from these estimated q(2)s were estimates of q(1); the estimated q(1)s in turn were compared with registered infant mortality rates in a period before the censuses to determine the extent of underregistration. One question we faced was whether the duration-based q(2)s or the age-based q(2)s should be chosen as the source of the estimated extent of underregistration of infant mortality. Conversion of q(2) to q(1) was accomplished by assuming that the relation between q(1) and q(2) in Egypt is the relation found in the "West" model life tables (namely, that q(1) equals 0.80q(2)).

Estimates for 1946-47

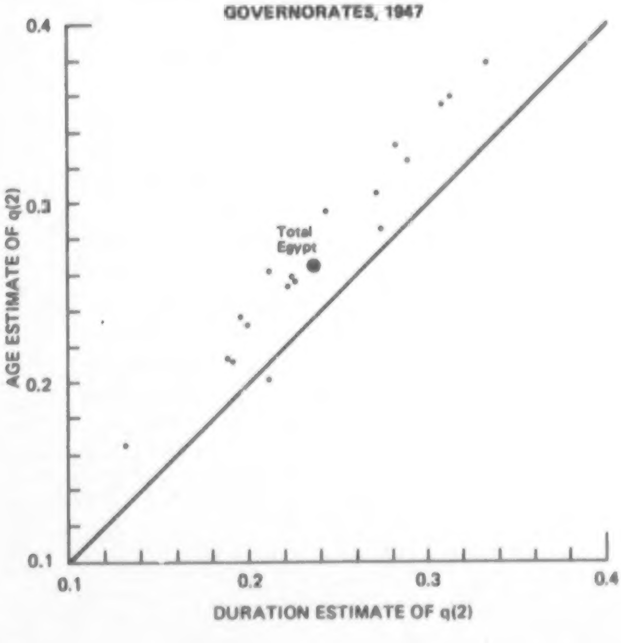
In Figure A-2 the average IMR in 1946-47 in the Health Bureau areas in each governorate is compared with the rate in the remainder of the governorate. The large differences indicate the existence of extensive underregistration in the areas not within Health Bureau administration.

Comparisons of child-survival-based estimates of infant mortality with registered infant mortality in the period prior to the 1947 census are complicated by large reductions in registered infant mortality from 1943 to 1947. The registered IMR for urban areas in Egypt declined from 225 to 171 during this period.

In the three panels of Figure A-3, there are three comparisons of q(1) derived from child survival as reported in the 1947 census with infant mortality rates as reported in the Health Bureau areas. The first panel compares age-based estimates of q(1) with the recorded IMR in 1945-46. The other two panels compare the recorded IMR in 1946-47 with duration-based and age-based estimates of q(1), respectively.

Note the following features of these comparisons:

(1) Age-based estimates of q(1), which are higher than duration-based estimates, are surpassed by the average IMR for 1945-46 recorded in the five urban governorates



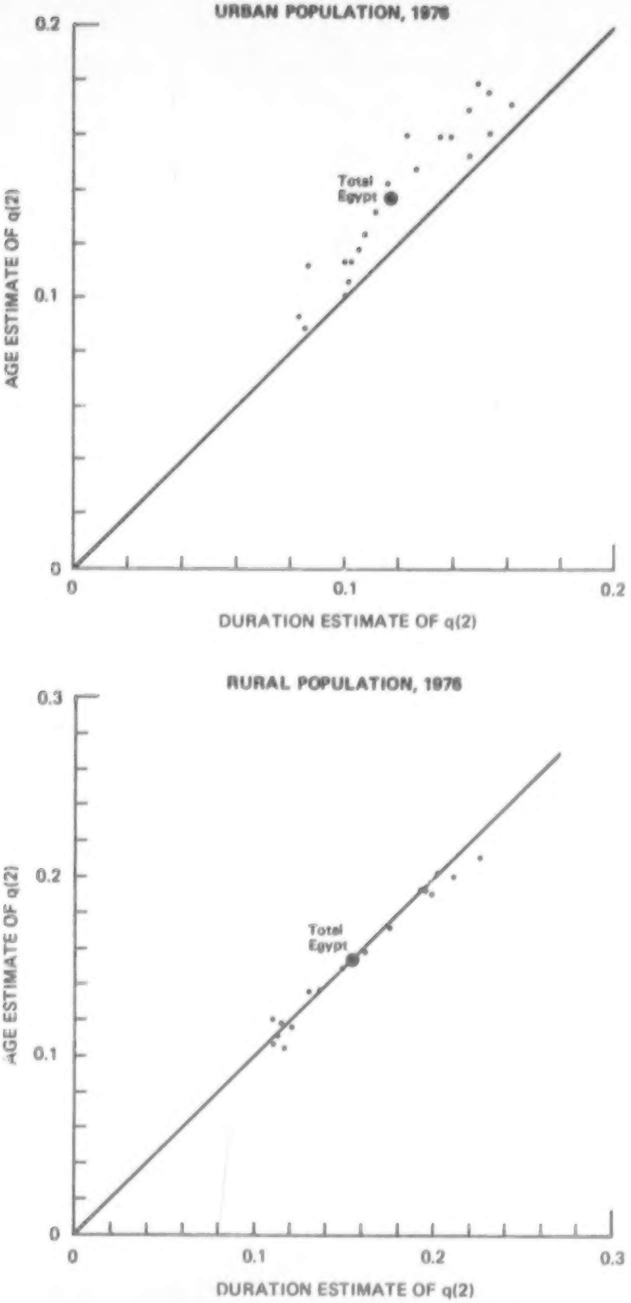


FIGURE A.1 Comparison of Child Mortality Estimates, q(2), Based on the Proportion Dead Among Children Ever Born to Women Married Less than Five Years (Duration Basis) and to Women Aged 20 to 24 (Age Basis), 1947 and 1976: Egypt

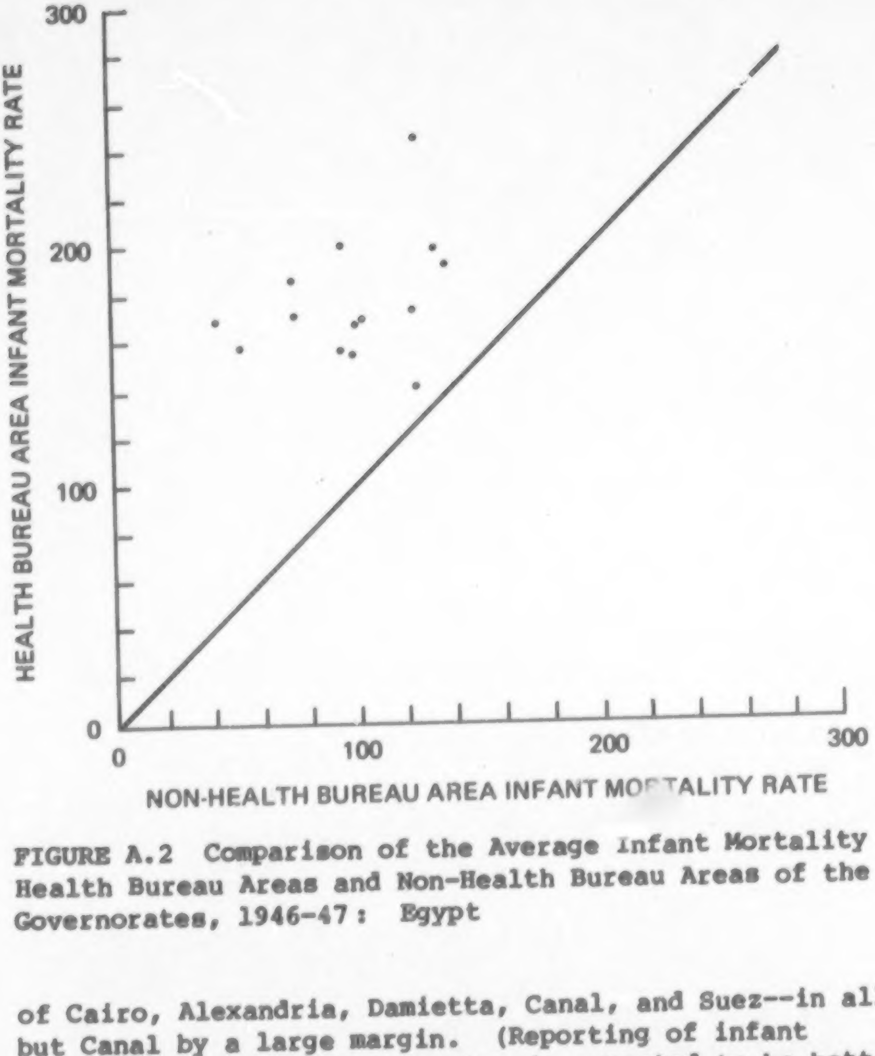


FIGURE A.2 Comparison of the Average Infant Mortality in Health Bureau Areas and Non-Health Bureau Areas of the Governorates, 1946-47: Egypt

of Cairo, Alexandria, Damietta, Canal, and Suez--in all but Canal by a large margin. (Reporting of infant mortality in these governorates is expected to be better than elsewhere but not more complete than reporting of births. Delayed registration, transferring into 1945 infant deaths not reported in earlier years, might offer one explanation for the higher recorded IMR.) Apparently q(1) estimated from child survival is too low when compared with the IMR for 1945-46. Yet, since the proportion dead among children ever born reflects the mortality over a several-year period centered one to two years before the census, comparing the average IMR for 1945-46 with estimates of q(1) from the 1947 census (taken in March) is appropriate.

(2) The duration-based estimates of q(1) are exceeded by the reported IMR even at the lower rates in 1946-47 in all five urban governorates, and in Behera and Aswan as well. When age-based estimates are compared with 1946-47 infant mortality rates, on the other hand, they are about equal to the recorded rates in Damietta, Alexandria, and Suez; are lower than the recorded rates in Cairo; and are slightly higher than the recorded rates in Canal.

(3) The imputation of more than 100 percent reporting of infant mortality rates in urban governorates, or of underestimation of infant mortality in these same areas from reported child survival is avoided only when the higher (age-based) estimates are compared with the lower (1946-47) infant mortality rates. The inclusion of 1947 infant mortality in the comparison even though the census was taken in March of that year is justified if we assume that there was some delay in the recording of deaths in the 1940s, so that many events labeled "1947" occurred in 1946. Egyptian vital statistics consistently pertain to year of registration, not year of occurrence.

Completeness of recording of infant mortality rates in the Health Bureau areas is judged, then, by the comparison of recorded rates in 1946-47 with age-based estimates of q(1) from the 1947 census. An alternative procedure, yielding not very different estimates of completeness, is to assume that the age-based q(1)s are too low (since they fall short of recorded data for 1945-46 in the urban governorates), and to adjust all age-based q(1)s upward by enough to match the IMR for 1945-46 in the urban governorates.

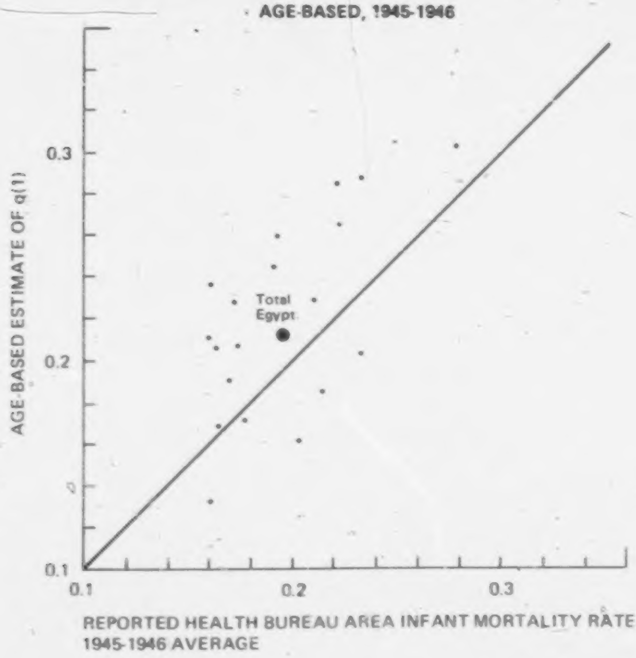
Estimates for 1975-76

In 1976, as noted earlier, there is very little difference between the age-based and duration-based q(2)s in the rural areas. In Figure A-4, age-based and duration-based q(1)s are compared with the registered IMR for 1975-76 for the urban areas of the governorates. The age-based estimates are virtually equaled by the registered rates in five of the urban areas; in the remaining governorates the registered rates fall short of the age-based estimates of q(1). On the other hand, the duration-based estimates are less than the registered IMRs in a majority of the urban areas, and in the urban population of Egypt as a whole. Again, we find the age-based estimates a better choice for calculating the extent of underregistration of infant mortality.

ESTIMATES OF COMPLETENESS OF INFANT DEATH REGISTRATION

Estimates of completeness of infant mortality rates by governorate in 1946-47 and 1975-76 are shown in Table A-1. For the earlier date estimated completeness in the Health Bureau areas, the non-Health Bureau areas, and the total area of each governorate is tabulated; for the later date estimated completeness in the rural areas, the urban areas, and the total area of each governorate is listed. For 1946-47 it is implicitly assumed that q(1) inferred from child survival in the census is the appropriate estimate of infant mortality for both the Health Bureau and non-Health Bureau sectors of each governorate.

These estimates show the universally more complete recording of IMR in the Health Bureau areas in 1946-47, and the almost universally more complete recording of IMR in the urban areas in 1975-76. For 1946-47 the estimated completeness of registration of infant mortality is less than 55 percent in all Upper Egypt governorates except Giza, between 55 and 65 percent in all Lower Egypt governorates, and fully complete in the urban governorates. For 1975-76, registration remains less than 65 percent complete in all Upper Egypt governorates except Giza and Aswan and is above 70 percent in all Lower Egypt governorates except Kafr-el-Sheik. In spite



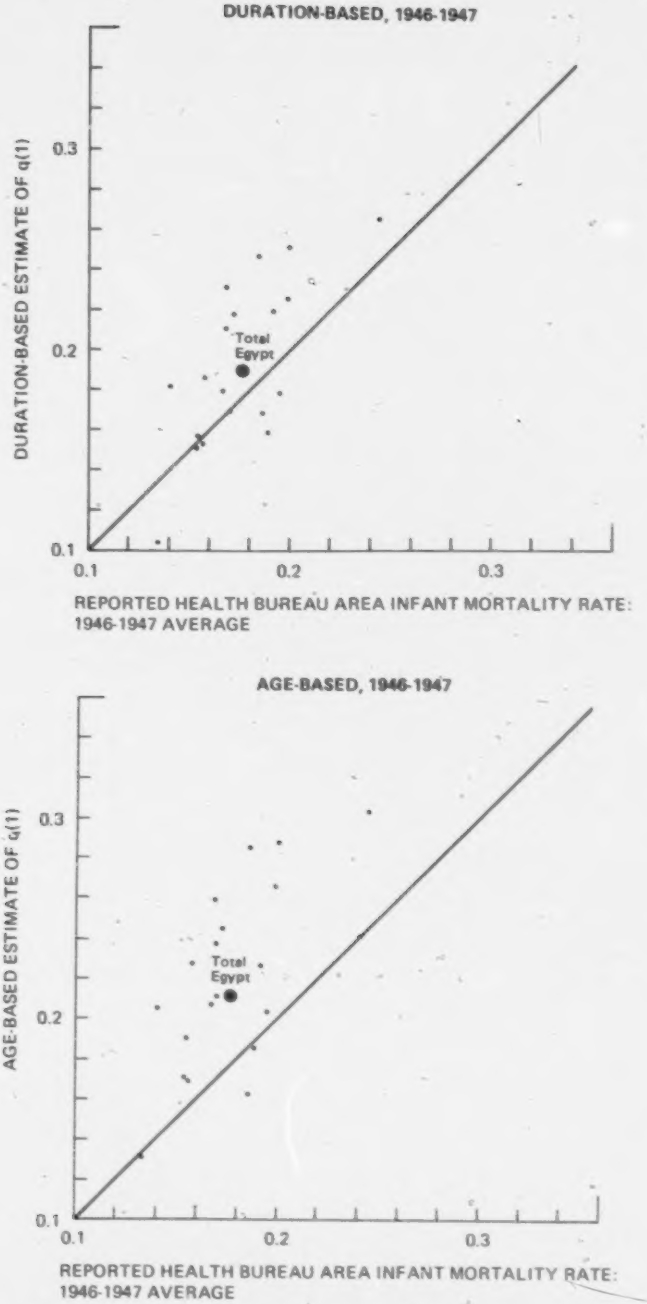


FIGURE A.3 Comparison of the Reported Infant Mortality Rates in Health Bureau Areas and Age- and Duration-Based Estimates of q(1) for the Governorates, 1945-47: Egypt

TABLE A-1 Estimated Completeness of Infant Mortality Rates by Governorate, 1946-47 and 1975-76: Egypt

	1946-47			1975-76		
Governorate	Health Bureau Areas	Non-Health Bureau Areas	Total Gover-norate	Urban Areas	Rural Areas	Total Gover-norate
Cairo	1.151	-- [a]	1.151	1.009	-- [b]	1.009
Alexandria	1.019	-- [a]	1.019	0.925	-- [b]	0.925
Canal	0.903	0.601	0.875	0.839[c]	-- [b]	0.839
Suez	0.960	0.861	0.953	0.795	-- [b]	0.795
Damietta	1.014	-- [a]	1.014	0.849	0.744	0.756
Dakahlia	0.684	0.607	0.627	0.993	0.674	0.725
Sharkia	0.810	0.486	0.567	0.835	0.712	0.730
Kalyubia	0.708	0.510	0.572	0.905	0.849	0.868
Kafr-el-Sheik[d]	--	--	--	0.855	0.515	0.576
Gharbia	0.818	0.519	0.600	0.978	0.995	0.989
Menoufia	0.841	0.603	0.654	1.011	1.033	1.036
Behera	0.925	0.498	0.615	0.872	0.684	0.724
Ismailia[b]	--	--	--	0.863	0.847	0.848
Giza	0.751	0.503	0.587	0.905	0.767	0.833
Beni-Suef	0.652	0.261	0.363	0.942	0.463	0.561
Fayoum	0.809	0.413	0.504	0.763	0.550	0.596
Minya	0.697	0.330	0.427	0.840	0.529	0.580
Assyiut	0.655	0.397	0.478	0.867	0.558	0.623
Souhag	0.694	0.225	0.364	0.873	0.497	0.577
Kena	0.714	0.179	0.354	0.862	0.358	0.460
Aswan	0.813	0.358	0.526	1.013	0.774	0.850

[a] No non-health bureau areas.
[b] No rural areas.
[c] Includes only Port Said in 1975-76.
[d] Not separate governorate in 1946-47.

of the passage of time and changed system of registration, geographic differences persist, and registration of infant deaths in Upper Egypt still covers only a little more than half the real infant mortality rate.

NATIONAL ESTIMATES OF ANNUAL INFANT MORTALITY

To estimate the national infant mortality rate for individual years from 1927 to 1961 (shown in Table 2), the IMR in the Health Bureau areas within each governorate was multiplied by the factor that converts the 1946-47 average Health Bureau IMR into the age-based estimate of IMR derived from child survival data in the 1947 census. This procedure makes appropriate allowance for the increasing fraction of the governorate population within Health Bureau areas. The increasing coverage of Health Bureaus tends to improve the overall completeness of recording of infant mortality, and any assumption of a constant degree of completeness for the governorate as a whole would not allow for the normal increase in completeness as Health Bureau areas came to include a larger fraction of the governorate's population.

We assumed that from 1962 to 1976, under the reorganized system of vital registration, the completeness of recording of IMR in each major subdivision (Cairo and Alexandria, urban Lower Egypt, rural Lower Egypt, urban Upper Egypt, and rural Upper Egypt) was constant at the level estimated for 1975-76. In Figure A-5, the estimated completeness of registration

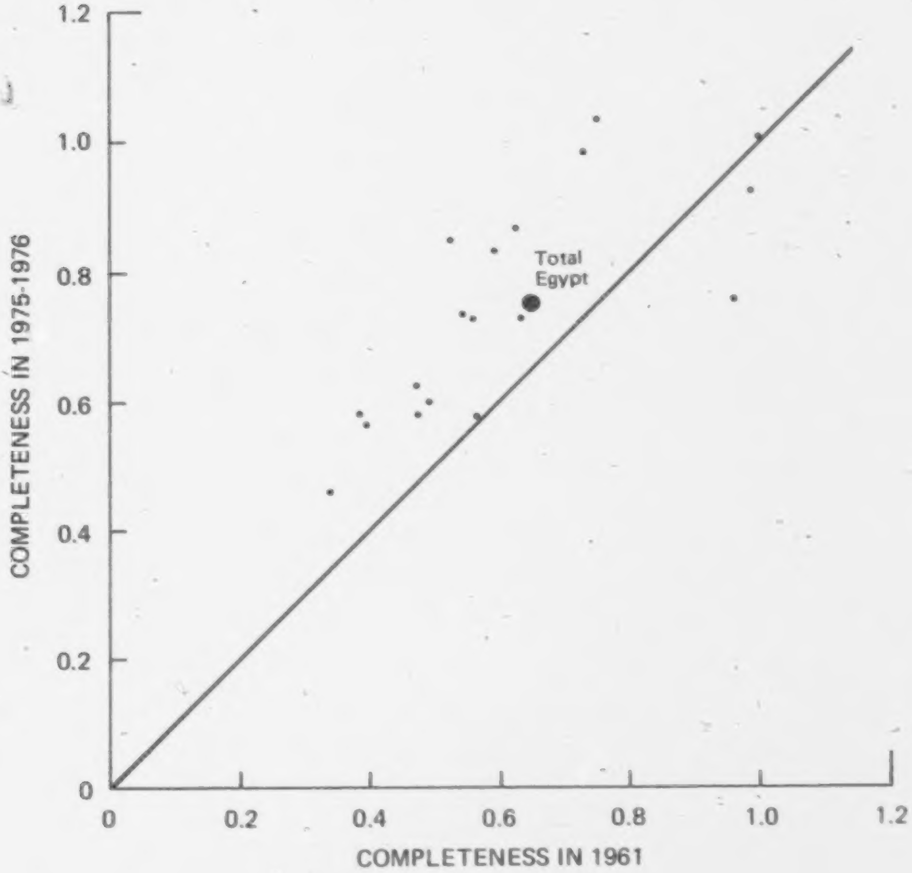


FIGURE A.5 Comparison of the Completeness of Registered Infant Mortality in 1961 and 1975-76 by Governorate: Egypt

in each governorate in 1961 (the IMR for the whole governorate based on registration relative to the Health Bureau IMR adjusted by the factor determined for 1946-47) is compared with the estimated completeness in 1975-76. Except for Cairo and Alexandria (virtually complete by both estimates), Damietta (an urban governorate in 1947 when 1961 completeness is determined, but with additional rural districts added later), Fayoum, and Aswan, the estimates of completeness in 1961 and 1975-76 fall close to a line in which completeness in 1961 is about 70 percent that of 1975-76. The consistent difference in completeness in most of the governorates (and the understandable exceptions of Cairo, Alexandria, and Damietta) is reassuring, since one set of estimates is derived from data taken from the 1947 census and from Health Bureaus in 1946-47, and the other set is derived from data taken from the 1976 census and from registration in whole governorates in 1975-76.

The question remains, however, whether the improvement in estimated completeness is justified, and whether the higher degree of completeness can be assumed to start in 1962 with the initiation of the new system of registration. Unfortunately, the 1960 census did not include tabulations of children ever born and children surviving to permit an independent verification of completeness just prior to the 1960 census; nor is there any verification of the rates in 1962. However, the sequence of registered infant mortality rates provides a clue that supports the validity of the conclusion that completeness increased in 1962 with the introduction of the new system of registration. In Figure A-6 the IMR derived from registration and the IMR adjusted by our estimates are shown for 1937 to 1976. According to the registered figures, IMR rose from 108 in 1961 to 134 in 1962 (24 percent); according to the adjusted figures, the increase was from 166 to 171 (3 percent). The registered figures show that the infant mortality rate did not fall as low as in 1961 until 1971, while the adjusted figures show that the rate was lower than in 1961 only two years later. The registered rates indicate a plateau of infant mortality during the 1960s, before the decline resumes in 1969. Without adjustments for completeness, the plateau is at a tangibly higher level than the IMR in the years 1958-61; when adjusted to reflect increased completeness beginning in 1962, the plateau is somewhat below the average for 1958-61. In other words, the acceptance of uniformly higher completeness beginning in 1962 does not

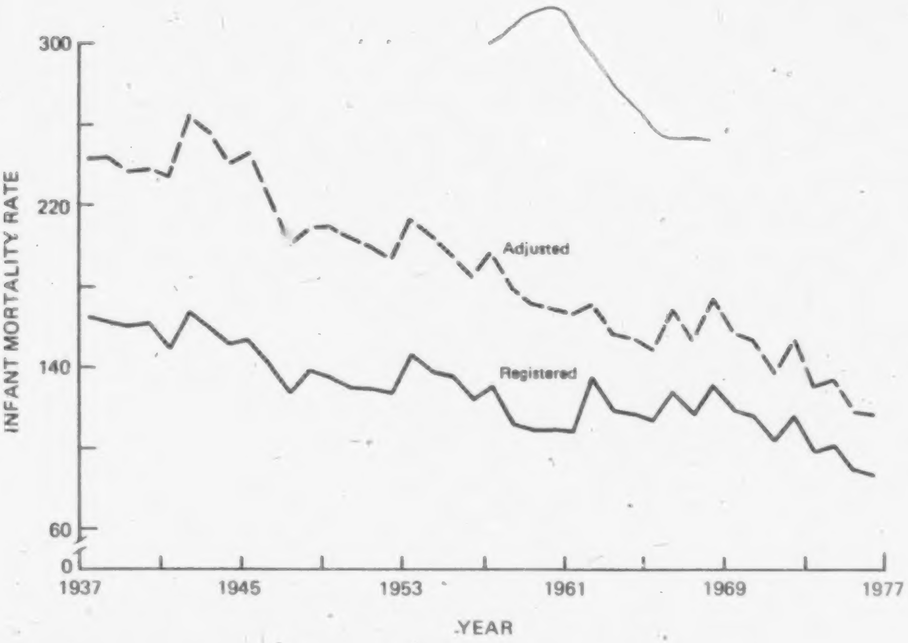


FIGURE A.6 Infant Mortality Rate Derived from Registration and After Adjustment for Age-Based Estimates of Completeness, 1937-76: Egypt

introduce a discontinuity in the estimated sequence of IMRs but rather repairs a discontinuity in the unadjusted sequence.

LIMITATIONS OF THE ESTIMATES

The adjusted set of infant mortality rates are certainly a better representation of the evolution of IMR in Egypt than the official, unadjusted figures. Adjustment by using child survival data from the censuses is an appropriate source of correction, although it is weakened, it must be conceded, by the differences between child mortality estimates derived from age-based and duration-based data and by the appearance of overreporting in the urban governorates for 1945-46.

The inconsistency of the two sets of estimates is almost certainly caused in large part by inaccurate reporting of age and of duration of marriage. When estimates of the number of married women by duration of marriage in 1947 are made from registered marriages by year of occurrence, number of divorces by year of occurrence and duration of marriage, and an allowance for attrition by mortality, the number of women married less than five years is 54 percent greater than the number married five to nine years. In the census, however, the number of those married less than five years is only 25 percent greater than the number in the next duration interval. The number at duration less than five is obviously understated in the census, probably because of overstatement of duration at durations near to five years. There is also a very large number of women at duration less than five who have no children, and another large number tabulated as having given no response to the questions about children ever born and children surviving. The many "no responses" recorded are the result of interviewers' having frequently left a blank instead of inserting a zero at this point in the questionnaire for women with no children. It was necessary to apply El-Badry's correction for converting "no response" to zero children, increasing the estimated number with no children to 53 percent of the women at duration less than five (El-Badry, 1961). The high proportion of childless women at duration less than five arises from overstatement of duration, so that many women married three and a half or four years are reported in duration interval 5-9, and from the custom in Egypt of formalizing marriage by a ceremony called "signing the book" typically several months before the bride and groom take up residence together. Thus the initiation of cohabitation is later than reported marriage, increasing the number of childless women reported as married less than five years.

Age misreporting is also severe for young women, and probably associated with marital status and perhaps parity. That is to say that a woman (not being able, typically, to report her own age) is estimated as over age 20 if she is married and has borne one or more children, and under age 20 if still unmarried. In short, the sequence of reported parities--by age or by duration of marriage--is unlikely to be accurately associated with true age or true parity, and thus the conversion factors for deriving q(2) from proportion dead among children ever born are not fully trustworthy. Moreover, there may be a tendency to omit dead children in reporting numbers of children ever born, a tendency that would contribute to a slight underestimate of q(2)--and in turn q(1)--from child survival statistics.

ANOTHER ESTIMATE OF THE COMPLETENESS OF INFANT DEATH REGISTRATION IN THE 1970S

Independent estimates of the completeness of recording of infant deaths in 1974-75 were derived from a survey conducted by the Central Agency for Public Mobilisation and Statistics (CAPMAS). Vital events were observed in a large nationwide sample of households and then checked against the registration records (see Appendix F).

The degree of non-registration of infant deaths determined in this survey was quite a bit larger than our estimates based on child-survival, as shown in Table A-2. The pattern was the same; both methods of estimation indicate a high rate of omission in the rural areas, with over 50 percent omission in rural Upper Egypt, and 22 to 30 percent in rural Lower Egypt. For the urban populations, the survey estimates of omission are up to twice as high as the child survival estimates. The child survival estimates may be too low, but if matching is imperfect, the survey estimates may be too high. We have retained the child-survival-based estimates from the 1976 census because they are more compatible with the estimates for earlier years derived from child survival data in 1947.

TABLE A-2 Estimated Understatement of Infant Mortality, 1970s: Egypt

Region	Underregistration of infant deaths, 1974-75, CAPMAS Survey	Understatement of infant mortality rate, 1975-76, Child Survival Method	Implied omission of infant deaths 1975-76, allowing for underregistration of births estimated by reverse projection
Cairo and Alexandria	.038	.016	.016
Urban Lower Egypt	.152	.104	.104
Urban Upper Egypt	.251	.121	.124
Rural Lower Egypt	.297	.220	.221
Rural Upper Egypt	.555	.463	.522

Appendix B
Estimation of Fertility

COMPLETENESS OF BIRTH REGISTRATION

As described in Chapter 4, reverse projection of the number of children aged 1 to 5 was used to provide a standard of comparison for the number of registered births. The details of the procedure are summarized below. The population aged 1 to 5 is designated as ${}_4P_1$ to connote the population in the interval four years in width (pre-subscript) beginning at exact age 1 (post-subscript), as in the symbols employed in life tables.

(1) The expected number of births in a governorate in the period one to five years before the census is calculated as ${}_4P_1^* \cdot (4 \cdot \ell_0 / {}_4L_1)$, where ${}_4P_1^*$ is the corrected number of persons 1 to 5 (${}_4P_1$ from the census, multiplied by an adjustment factor), and ${}_4L_1 / 4 \cdot \ell_0$ is the estimated proportion surviving from birth to the age interval 1 to 5 according to the mortality in the years before the census.

(2) ${}_4L_1$ is taken from a "West" model life table (for the two sexes combined) in which ${}_1q_0$ is equal to the average value of the registered infant mortality rate in the governorate for the years in question, adjusted for underregistration as described in Appendix A.

(3) ${}_4P_1^*$ is the enumerated population 1 to 5, multiplied by a factor common to all governorates. This factor is the multiplier required to adjust ${}_4P_1$ for the combined populations of Cairo and Alexandria to yield a reverse projection that matches the number of registered births in the two metropolitan centers combined. In 1976 no adjustment of ${}_4P_1$ was needed; in 1947 a factor of 1.06 was required to bring the

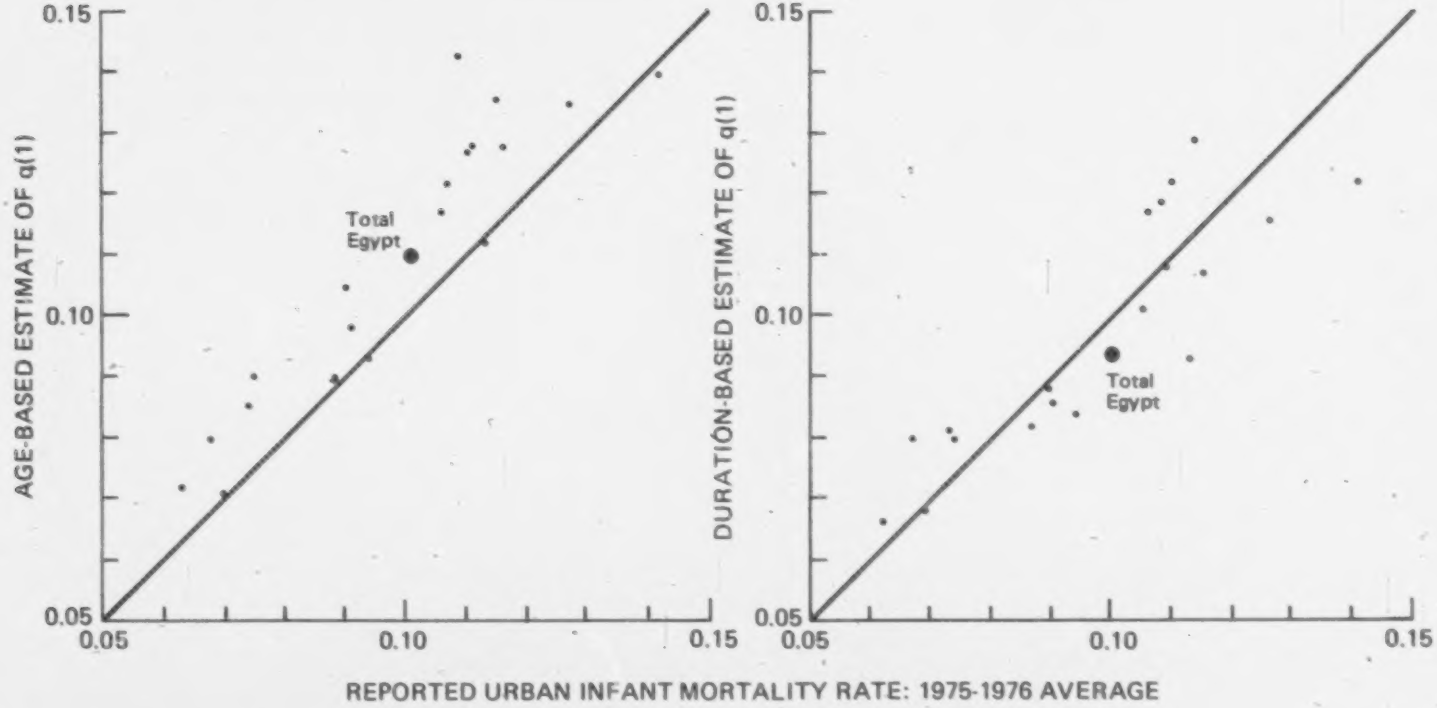


FIGURE A.4 Comparison of Age- and Duration-Based Estimates of q(1) to Average Reported Infant Mortality Rates for Urban Areas of Governorates, 1975-76: Egypt

reverse-projected ${}_4P_1$ in Cairo and Alexandria into line with the number of registered births.

(4) The registered births compared with the reverse-projected ${}_4P_1$ are from the period extending from exactly five years to exactly one year before the census--if no allowance is made for age misstatement in the determination of ${}_4P_1$, or for delay in the registration of births. Children less than 1 year old are almost certainly included in ${}_4P_1$, and children approaching 5 are omitted. The time of birth of the ${}_4P_1$ cohort thus extends from less than one to less than five years before the census, rather than from exactly one to exactly five years. The delay in birth registration in Egypt displaces the recorded time of birth by some unknown fraction of a year toward the date of the census. The 1976 census was taken in November, so registered births in 1972-1975 (from 10 1/2 months to 4 years 10 1/2 months before the census) were judged appropriate for comparison with reverse-projected ${}_4P_1$. For the 1947 census, which was taken in March, births for 1942.5 to 1946.5 were judged to be appropriate for comparison (half of the births registered in 1942 and 1946 were added to the births registered in 1943, 1944, and 1945).

Table B-1 lists estimates of completeness of birth registration by governorate in the 1940s and 1970s, with separate figures for the rural and urban populations in the 1970s. In the 1940s completeness of birth registration in all of the governorates of Upper Egypt except Giza is estimated as 85 percent or less; in all of the lower Egyptian governorates completeness is estimated as 88 percent or more. In the 1970s, urban registered births exceed the estimates from reverse projection of ${}_4P_1$ in several Lower Egypt governorates; the only consequential extent of estimated underregistration is in rural Upper Egypt.

Underregistration of Births in the late 1950s

Estimates of completeness of birth registration by governorate in 1956-59, derived from reverse projection of ${}_4P_1$* in the 1960 census (September 20), are shown in Table B-2. As for the 1940s and 1970s, values of $4 \cdot \ell_0 / {}_4L_1$ for the reverse projection were obtained from "West" model life tables and corrected infant mortality rates. To match registered births in

TABLE B-1 Estimates of Completeness of Birth Registration in the Governorates Based on Reverse Projection of the Census Population Aged 1-4; 1940s and 1970s: Egypt

Governorates	1940s[a]	1970s[b]		
		Total Governorate	Urban Areas	Rural Areas
Major Metropolitan				
Cairo	1.004	1.015	1.015	--[c]
Alexandria	0.993	0.977	0.977	--[c]
Lower Egypt				
Damietta	1.107	1.053	1.149	1.021
Dakahlia	0.917	1.037	1.153	1.007
Sharkia	0.881	0.990	1.042	0.978
Kalyubia	0.919	0.963	0.869	1.026
Kafr-el-Sheik[d]	--	0.925	1.034	0.903
Gharbia	0.930	1.024	1.067	1.006
Menoufia	1.037	1.045	0.934	1.066
Behera	0.901	0.998	1.017	0.993
Ismailia[c]	--	0.743	0.530	0.894
Upper Egypt				
Giza	0.908	0.958	0.950	0.965
Beni-Suef	0.846	0.926	1.043	0.896
Fayoum	0.836	0.887	0.976	0.863
Minya	0.853	0.871	0.992	0.848
Assyiut	0.826	0.887	0.976	0.856
Souhag	0.753	0.940	1.093	0.887
Kena	0.673	0.877	0.957	0.856
Aswan	0.727	0.987	0.826	1.080
Egypt	0.890	0.964	0.993	0.946

[a] Registered births mid-1942 to mid-1946 relative to reverse projection of $_4P_1$ in 1947 census ($_4P_1$ raised by 5.7 percent).

[b] Registered births 1972-75 relative to reverse projection of $_4P_1$ in 1976 census.

[c] No rural areas.

[d] Not a separate governorate in 1947.

Cairo and Alexandria combined, $_4P_1$ was multiplied by 1.025. Also, a special adjustment was made in Cairo, Giza, and Kalyubia, because beginning in 1955 births registered in two districts in Giza and one district in Kalyubia were transferred to Cairo. The 1960 census recorded the population of these districts in Giza and Kalyubia rather than in Cairo. Therefore the registered births in the transferred districts were reallocated to

TABLE B-2 Estimates of Completeness of Birth Registration in 1956-59 by Governorate, Based on Reverse Projection of the 1960 Census Population Aged 1-4: Egypt

Major Metropolitan	
Cairo	1.004
Alexandria	0.992
Lower Egypt	
Damietta	0.836
Dakahlia	0.897
Sharkia	0.905
Kalyubia	0.965
Kafr-el-Sheik	0.696
Gharbia	0.900
Menoufia	1.004
Behera	0.957
Upper Egypt	
Giza	0.830
Beni Suef	0.780
Fayoum	0.850
Minya	0.836
Assyiut	0.716
Souhag	0.668
Kena	0.580
Aswan	0.738
Egypt	0.857

the original governorates before comparison with the reverse-projected ${}_4P_1$.

Estimated completeness of birth registration in the late 1950s is highly correlated with estimated completeness in the 1940s except in the governorates of Damietta, Giza, Beni Suef, Kena, Souhag, and Assyiut. (See Figure B-1; the dots representing the 6 mentioned governorates lie more to the right of the 45 degree line, indicating higher estimated completeness in the 1940s than in the late 1950s.) An examination of annual registered births by governorate, and even by district within governorates, suggests that the low estimated completeness for 1956-59 in these governorates was caused by particularly severe underregistration in 1956 and

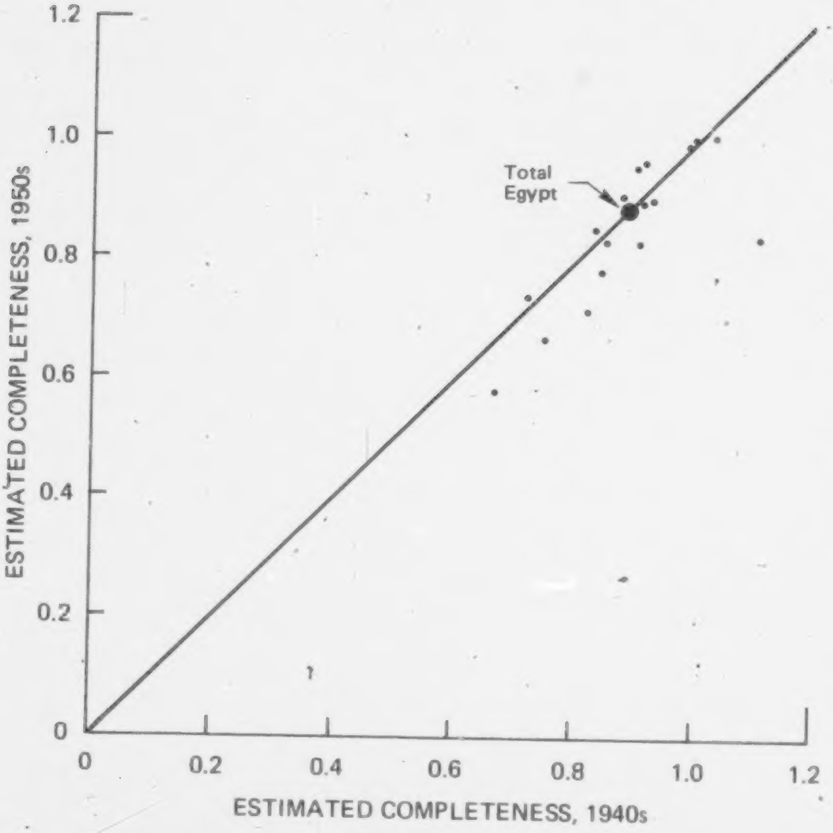


FIGURE B.1 Comparison of the Estimated Completeness of Birth Registration in the Governorates in the 1940s and the 1950s: Egypt

1957, perhaps associated with the Suez crisis. The evidence is in the form of especially low registered birth rates in those two years in the governorates in which estimated completeness was lower in 1956-59 than in 1942-46; and very low birth rates in the districts in the bottom quartile of rates within the governorates. A conspicuous instance is the governorate of Damietta: in Damietta city the birth rate calculated from registered births falls from 46.0 per thousand in 1955 to 16.2 in 1956 and 2.8 in 1957 (only 198 births recorded in a population of 71,000!). Obviously many births were not registered or, if registered, were not recorded in the official vital statistics.

Other indications of severe underregistration of births during the 1950s come from comparing the expected survivors of the cohorts born in the 1950s with census counts in 1960 and 1976. In Table B-3, the population under age 10, as expected from registered births and estimated mortality, is compared with enumerated populations in 1937, 1947, 1960, and 1976. In each

TABLE B-3 Comparison of the Population Estimated from Projected Registered Births and Enumerated in the Census: Egypt

Part A. Population Under 10

Year	Estimated Population, 0-9	Enumerated Population, 0-9	Ratio (Estimated to Enumerated)
1937	4,305	4,316	0.997
1947	4,842	4,985	0.971
1960	7,164	7,931	0.903
1976	9,904	9,724	1.018

Part B. Population 15-24

Year	Estimated Population, 15-24	Enumerated Population, 15-24	Ratio (Estimated to Enumerated)
1960	3,966	3,949	1.004
1976	6,537	7,075	0.924

Note: Births by five-year periods were projected using survival factors taken from female "West" model life tables chosen based on an estimate of q(1). q(1) was assumed to equal the average estimated infant mortality rate for the appropriate five-year period. For 1960 estimates of the population 15-24, mortality level 8 was used for projecting birth cohorts from the age group 5-9 to 15-19 and 20-24 as appropriate. For the 1976 estimates, mortality level 10 was used.

instance except 1960 the estimated population approximately equals the enumerated; if births are underregistered, the undercount of the population is of about the same extent. In 1960, however, the ratio of expected to counted is 7 to 10 percent less than at other dates--a difference caused, it seems clear, by especially large underregistration of births in the 10 years before the 1960 census.

The second section of Table B-3 compares the calculated survivors of births registered in 1936-45 with the enumerated population at ages 15-24 in 1960, and also the calculated survivors of births registered in 1952-61 with the enumerated population at ages 15-24 in 1976. In 1960, the expected population matches the enumerated very closely (again underregistration is apparently balanced by an undercount), but in 1976 the population expected from births registered in 1952-61 falls 8 percent short of the number recorded in the census. Faced with this evidence of especially poor registration in the 1950s, we have assumed a steady increase in the number of births from 1947 to 1960 to provide figures by five-year time periods (for use in the projection), but present no estimates of births by single years.

The evidence of especially acute underregistration of births in 1956 and 1957, at least in some governorates, implies that adjustment of births in 1960 and 1961 for underregistration estimated for 1956-59 would yield estimates that are too large. The adjustments for 1960-61 births are especially important for this report, because the census of 1960, together with corrected numbers of births, makes possible the calculation of refined measures and indexes of fertility for Egypt and its major regions. To avoid misleadingly high estimates of fertility in 1960 by overcorrection (in Damietta, for example), underregistration of births in 1960 in each governorate was estimated as the average of the rates of underregistration for 1942-46 and 1972-75. In short, the estimation of underregistration for 1956-59 obtained by reverse projection of ${}_4P_1$ from the 1960 census was not used as the basis for estimates in other years.

Estimated Births, 1927-76

Because the average birth rate for 1942.5 to 1946.5, adjusted for the extent of underregistration that we estimated, agrees exactly with the average of El-Badry's

(1965) estimates for those years (formed by accepting the Health Bureau birth rates for the urban governorates as estimates for the rates in the urban Health Bureau areas in other governorates, and assigning the birth rate of the rural Health Bureau areas in each governorate to the entire rural population), we accepted El-Badry's estimates for 1934 to 1947 and extended his average correction factor for the 1930s (1.12) back for the years 1927 to 1933. The adjustment applied in 1960 (the average of the adjustments for 1942.5-1946.5 and 1972-75) was 1.08 times registered births. It was assumed that this correction declined linearly from 1960 to 1972. Estimates of births (and birth rates or other fertility measures) for subdivisions of Egypt were attempted only for periods centered on the censuses of 1947, 1960, and 1976. For other years we attempted only to prepare adjusted figures for births and crude birth rates for Egypt as a whole.

CONSTRUCTION OF FERTILITY MEASURES AND INDEXES

Registered births, adjusted for underregistration, were used to create annual estimates of the crude birth rate, 1927-76. (The denominator was obtained by geometric interpolation of the population enumerated in the censuses of 1927, 1937, 1947, 1960, and 1976 to the midpoint of each year.) In Table 4 (in Chapter 2), the general fertility rate, the total fertility rate, and the three fertility indexes (I_f, I_m, and I_g) are shown for the census years from 1937 to 1976. For 1947 these additional measures are given for Cairo plus Alexandria and for the remainder of Egypt; for 1960 the metropolitan populations, Lower Egypt, and Upper Egypt are shown; and for 1976 the rural and urban sectors of the two major regions are represented separately. In this section of Appendix B the methods employed in calculating these additional measures are described.

Before fertility measures for 1960 were calculated for the Cairo, Giza, and Kalyubia governorates, some of the births registered in Cairo were reallocated to the other two governorates to correspond to the geographic division of the population in the census. From 1955 through 1961 births in the El Giza and Embaba districts (originally part of Giza) and the Shubra el Balad district (originally part of Kalyubia) were tabulated with births in Cairo, but in the 1960 census the populations in these districts were counted in their original governorates.

General Fertility Rate

The general fertility rate was calculated by dividing the number of births attributed to the area in question by the enumerated female population aged 15 to 49. I_f, I_m, and I_g were calculated by the standard formulae:

$$I_f = \text{Births}/\sum F_i w_i;$$
$$I_g = \text{Births}/\sum F_i m_i; \text{ and}$$
$$I_m = \sum F_i m_i/\sum F_i w_i,$$

where F_i is the fertility rate in the i^{th} five-year age interval (of the seven from 15-19 to 45-49) of married Hutterites (a population with very high marital fertility); m_i and w_i are, respectively, the number of married women and the number of women in the i^{th} interval (Coale, 1965). In the Egyptian censuses the number married is listed only for women 16 and over; therefore the true number of married women 15-19 may be somewhat understated because of unrecorded married women at age 15.

Total Fertility Rate

The total fertility rate was estimated from the calculated value of I_f. This index is the ratio of the number of births women have to the number they would have if subject to F_i, the schedule of age-specific marital fertility of the Hutterites. If I_f were 1.0, the population in question would have fertility as high, on the average, as the married Hutterite schedule. The total fertility rate this schedule implies is 12.4 births per woman; hence the total fertility rate is calculated as $12.4(I_f)$, an approximation that is quite close in populations (like that of Egypt) in which marriage is early and the age structure of marital fertility is not strongly affected by voluntary control.

Table B-4 lists fertility measures and indexes for the governorates of Egypt in 1960 and 1976 with separate figures for rural and urban populations at the later date. Note that in most of the Upper Egypt governorates (all but Aswan) the value of I_g at both dates is much the same (with the 1976 estimates a little higher), as is also true of Behera and Menoufia in Lower Egypt. Among the remaining governorates, there is a strong correlation between the two values, but with consistently lower I_g (especially in Cairo and Alexandria) in 1976. Figure B-2

TABLE B-4 Measures and Indexes of Fertility by Governorate, 1960 and 1976: Egypt

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1960 Total Governorate							
Cairo	42.4	187.9	5.99	0.483	0.669	0.722	.226
Alexandria	39.5	180.0	5.79	0.467	0.673	0.694	.219
Lower Egypt							
Damietta	42.5	197.7	6.40	0.516	0.674	0.765	.215
Dakahlia	46.7	213.9	7.01	0.565	0.731	0.772	.218
Sharkia	50.7	228.1	7.53	0.607	0.764	0.795	.222
Kalyubia	55.2	253.7	8.37	0.675	0.820	0.824	.218
Kafr-el-Sheik	45.5	202.5	6.70	0.540	0.735	0.735	.225
Gharbia							
Menoufia	45.5	209.5	7.14	0.576	0.742	0.777	.217
Behera	43.9	190.4	6.24	0.503	0.692	0.727	.231
Upper Egypt							
Giza	47.7	208.0	6.75	0.544	0.692	0.785	.229
Beni Suef	47.0	192.5	6.44	0.519	0.706	0.735	.244
Fayoum	51.0	219.3	7.23	0.583	0.746	0.781	.233
Minya	51.5	218.5	7.23	0.583	0.754	0.773	.236
Assyiut	48.8	218.6	7.22	0.582	0.775	0.751	.223
Souhag	43.5	189.7	6.27	0.506	0.683	0.741	.229
Kena	45.3	194.3	6.36	0.513	0.648	0.792	.233
Aswan	50.6	211.5	6.94	0.560	0.712	0.789	.239
Egypt	46.3	204.5	6.71	0.541	0.716	0.755	.226

1976 Total Governorate

Cairo	32.1	123.1	3.93	0.317	0.533	0.596	.261
Alexandria	30.3	117.4	3.73	0.301	0.529	0.568	.258
Lower Egypt							
Damietta	35.0	152.2	4.85	0.391	0.585	0.669	.230
Dakahlia	35.9	155.1	5.12	0.413	0.612	0.675	.231
Sharkia	39.7	171.6	5.89	0.475	0.699	0.679	.224
Kalyubia	44.9	201.2	6.53	0.527	0.771	0.684	.223
Kafr-el-Sheik	39.5	169.6	5.57	0.449	0.703	0.638	.233
Gharbia	35.3	150.2	4.95	0.399	0.638	0.626	.235
Menoufia	38.4	175.5	5.88	0.474	0.704	0.674	.219
Behera	39.7	176.0	5.75	0.464	0.680	0.682	.226
Upper Egypt							
Giza	45.0	189.1	6.03	0.486	0.699	0.695	.238
Beni Suef	44.4	197.2	6.57	0.530	0.724	0.732	.225
Fayoum	47.3	220.0	7.28	0.587	0.777	0.755	.215
Minya	46.9	209.0	6.94	0.560	0.781	0.717	.224
Assyiut	43.6	197.7	6.53	0.527	0.746	0.706	.221
Souhag	40.0	175.4	5.83	0.470	0.704	0.668	.228
Kena	42.8	185.4	6.15	0.496	0.662	0.749	.231
Aswan	41.9	176.7	5.82	0.469	0.650	0.721	.237
Egypt	40.5	172.7	5.48	0.442	0.666	0.663	.235

TABLE B-4 (continued)

	Crude Birth Rate	General Fertility Rate	Total Fertility Rate	Index of Overall Fertility I_f	Index of Marital Fertility I_g	Index of Proportion Married I_m	Women 15-49 Divided by Total Population
1976 Urban Areas							
Cairo	32.1	123.1	3.93	0.317	0.533	0.596	.261
Alexandria	30.3	117.4	3.73	0.301	0.529	0.568	.258
Lower Egypt							
Damietta	28.3	113.0	3.70	0.298	0.480	0.622	.250
Dakahlia	30.4	119.4	3.84	0.310	0.516	0.601	.255
Sharkia	37.3	150.8	4.90	0.395	0.659	0.599	.247
Kalyubia	49.1	206.9	6.50	0.524	0.768	0.683	.237
Kafr-el-Sheik	34.7	141.6	4.61	0.372	0.620	0.600	.245
Gharbia	31.7	123.7	3.99	0.322	0.560	0.576	.256
Menoufia	37.5	156.6	5.17	0.417	0.681	0.617	.239
Behera	37.4	155.8	5.05	0.407	0.659	0.612	.240
Upper Egypt							
Giza	41.2	162.2	5.12	0.413	0.647	0.638	.254
Beni Suef	39.5	167.3	5.53	0.446	0.665	0.670	.236
Payoum	42.5	186.5	6.15	0.496	0.724	0.685	.228
Minya	38.6	165.3	5.38	0.434	0.697	0.622	.234
Assyiut	37.9	164.8	5.42	0.437	0.713	0.613	.230
Souhag	40.3	177.1	5.78	0.466	0.739	0.631	.228
Kena	44.7	192.1	6.32	0.510	0.743	0.687	.233
Aswan	41.1	172.2	5.52	0.445	0.623	0.714	.239
Egypt	37.8	150.5	4.60	0.371	0.609	0.609	.251

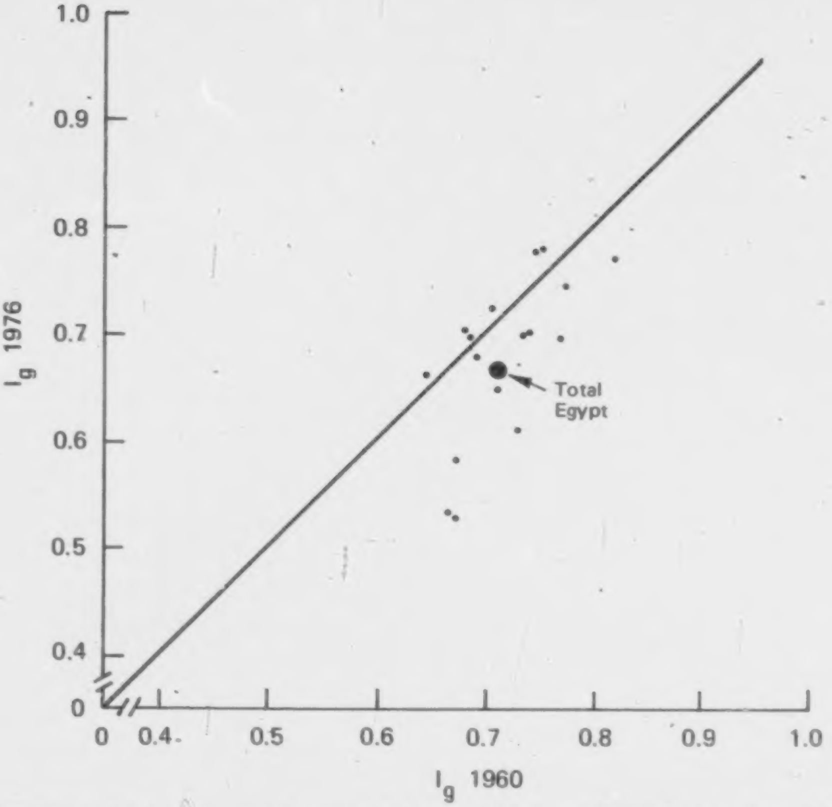


FIGURE B.2 Comparison of the Index of Marital Fertility (I_g) in 1960 and in 1976 for the Governorates: Egypt

shows this correlation in a comparison of the values of I_g in 1960 and 1976 in the governorates.

CAPMAS ESTIMATE OF COMPLETENESS OF BIRTH REGISTRATION IN THE 1970S

Independent estimates of underregistration of births have been obtained in the 1974-75 vital events survey by CAPMAS (see Appendix F). In Table B-5 these estimates are compared with those obtained by reverse survival. As with infant mortality underregistration, the survey-based estimates are uniformly higher than those based on reverse survival. It is likely that our reverse survival procedure understates underregistration because we chose

TABLE B-5 Estimates of Underregistration of Births in the 1970s by Major Regions: Egypt

Region	Underregistration of Births: 1974-75, CAPMAS Survey	Underregistration of Births: 1972-75, Reverse Survival of Census Population Aged 1-4
Cairo and Alexandria	.023	-.004
Urban Lower Egypt	.053	.004
Urban Upper Egypt	.093	.025
Rural Lower Egypt	.110	.003
Rural Upper Egypt	.244	.112

not to adjust the 1976 ${}_4P_1$, since reverse projection without adjustment so closely matched registered births in Cairo and Alexandria. Registered births in urban Damietta, Dakahlia, and Gharbia are well in excess of the reverse-projected numbers; based on these governorates, an upward adjustment of ${}_4P_1$ by 3 or 4 percent would be justifiable, adding 3 or 4 percent to all estimates of underregistration. But the difficulties of establishing a true match between survey-recorded and registered births establishes the possibility of an overestimate of underregistration from the survey.

We have chosen to retain the possibly low estimates of underregistration based on reverse projection to maintain better consistency with estimates described earlier.

Appendix C
Estimation of Mortality (Other than Infant and Child Mortality)

This appendix adapts a recently developed method for estimating the completeness of registration of deaths above age 10 for application to registered male and female deaths in Egypt for every year from 1937 to 1976.

The method is applicable to populations in which no major sustained changes in fertility began more than 15 or 20 years before the year for which the estimate is made. Since our estimates show no continued decline (or increase) in fertility in Egypt before the 1960s, the method seems suitable in this context. Because the basic relation upon which the method depends is a relation characteristic of stable populations, it might appear that approximately constant mortality is also an essential condition, but in practice the estimates are only slightly affected by recent trends in mortality (Preston et al., 1980; an earlier approach can be found in Carrier, 1958).

ESTIMATING COMPLETENESS OF DEATH REGISTRATION

It can be shown that in a stable population, the number of persons at age $\underline{a}$, $N(a)$, equals the sum of the number of deaths at each higher age $\underline{x}$, $D(x)$, multiplied by $\exp(r(x-a))$, where r is the population's rate of growth. Call the number calculated in this way $\hat{N}(a)$. Thus,

$$\hat{N}(a) = \sum_{x=a}^{\omega} D(x) \exp(r(x-a)).$$

The number of persons by five-year age intervals can also be determined from $\underline{r}$ and the number of deaths, as ${}_5\hat{N}_a = 2.5\ (\hat{N}(a) + \hat{N}(a+5))$; and the sum of ${}_5\hat{N}_x$'s for all ages above a is the estimated number at ages a and over, $\hat{N}(a+)$. In a stable population with a known growth rate, $\hat{N}(a+)/N(a+)$ is the same for all ages, except for inaccuracies in the data--this ratio is equal to 1.0 if deaths are completely recorded, and equal to C, the relative completeness of the recording of deaths compared to the population, if deaths are not completely recorded.

If the $\hat{N}(a+)/N(a+)$ method of estimating completeness of death registration is applied to Egyptian data (i.e., to the number of deaths registered at different ages in a given year, and to the number of persons in different age intervals interpolated from appropriate censuses), the estimates consistently indicate that deaths are very much more than fully registered. The extent of apparent overregistration (i.e., $\hat{N}(a+)/N(a+)$) rises steadily with age (see Figure C-1 for an example).

Persistent overregistration of deaths is not believable, but another explanation, overstatement of age at death, may be possible. A frequent faulty characteristic of mortality data in populations that cannot supply precise data on age is overstatement of age at death, particularly at advanced ages. Such overstatement causes artificially high values of $\hat{N}(a+)/N(a+)$ at all ages, and rising values of $\hat{N}(a+)/N(a+)$ with age. For example, suppose that reported deaths have been transferred from younger ages to over 80. Recall that

$$\hat{N}(a) = \sum_{x=a}^{\omega} D(x) \exp(r(x-a)).$$

Having too many deaths over age 80 leads directly to too large a value of $\hat{N}(80)$ but also (less directly) increases $\hat{N}(a)$ at younger ages as well (when the growth rate is positive). The exaggeration of $\hat{N}(a)$ at all younger ages (and hence of $\hat{N}(a+)$) results from exaggeration of x in the exponential factor $\exp(r(x-a))$ that multiplies $D(x)$ in the calculation of $\hat{N}(a)$. The persistent appearance in calculations for Egypt of $\hat{N}(a+)/N(a+)$ that is always greater than 1.0, and that rises to very high values (over 3.0) at ages 75 and above is consistent with extensive overstatement of age at death.

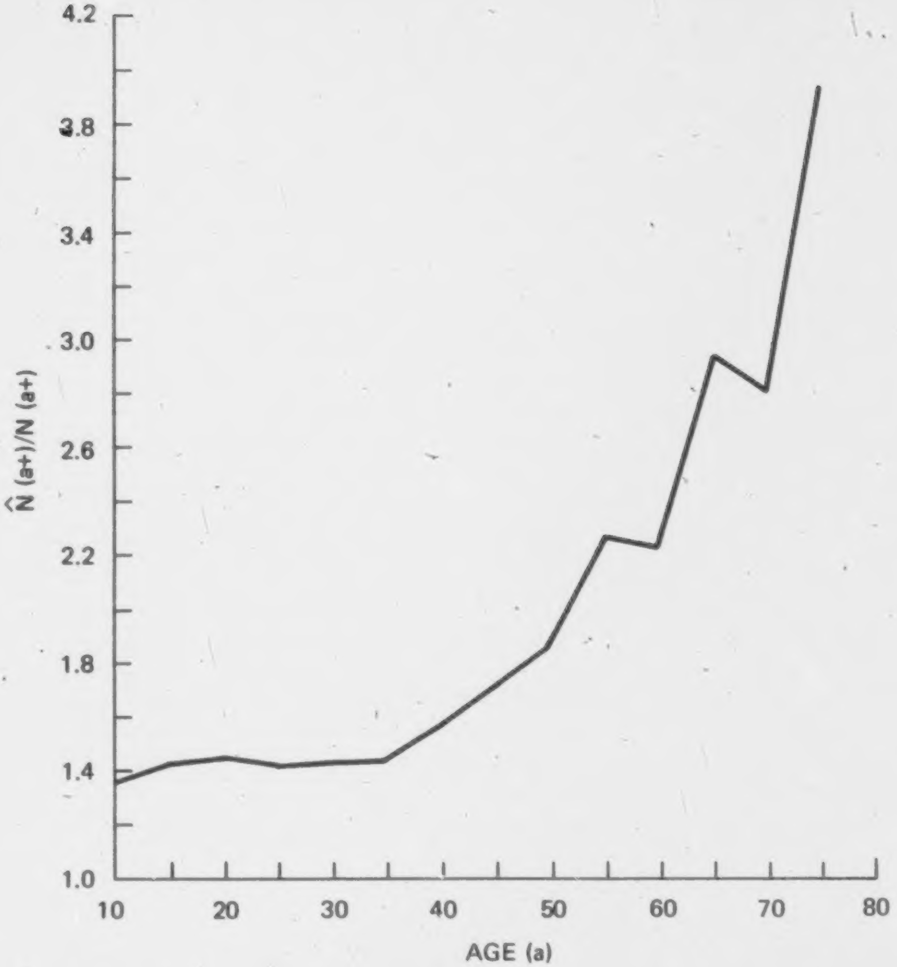


FIGURE C.1 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, Males, 1941-42: Egypt

ESTIMATING THE NATURE AND EXTENT OF FALSE REPORTS OF AGE AT DEATH AT VERY HIGH AGES

The possibility that overstatement of age at death is the cause of the progressively rising estimates of over-registration of deaths in Egypt led to a comparison of the distribution of deaths by age with a standard that approximates the true distribution. The standard chosen was a "South" model stable population incorporating the broad overall steepness of the recorded age distribution (as interpolated between censuses) and the estimated rate of increase. "Overall steepness" was calibrated by the ratio (population 10 to 50)/(population 10+). At this point the comparison and analysis for males in 1941-42 will be described; a similar comparison was made for every year for males and females. Two pairs of cumulative proportionate distributions are compared in Figure C-2: one pair of cumulative distributions of the population by age and one pair of cumulative distributions of deaths by age, all beginning at age 10. Each pair of distributions compares the distribution from Egyptian data with the corresponding distribution in the approximately matching stable population.

The cumulative age distribution of the Egyptian population is fairly closely fitted by the stable population, but the cumulative distribution of deaths differs markedly from the stable as early as age 20, and by a widening margin. The slight differences between the cumulative age distribution of the population and the corresponding stable population are explained by the defects in the recorded population. The deficits at ages 15 to 35 in the recorded population create a gap between its cumulative proportionate distribution and that of the corresponding stable figure that reaches a maximum at age 35; then the two cumulative distributions converge.

In sharp contrast is the ever widening gap between the cumulative distribution of recorded deaths and the corresponding stable distribution. The gap can hardly be explained by an inappropriate choice of the stable distribution of deaths, given the close fit to the recorded age distribution of the stable population incorporating exactly the same distribution of deaths. The fault must lie with the recorded proportionate distribution of deaths.

One might suppose that the high proportion of deaths over 80--more than three times the proportion in the stable population--is explained by a tendency for age at death to be overstated for older decedents. Suppose such overstatement began at age 50. Only above age 50 would the gap between the cumulative distributions begin. The existence of the gap virtually from age 10 suggests either a substantial incidence of overreported ages at death at all ages or some form of direct transfer of reported deaths from all ages to the highest category.

Figure C-3 illustrates, for five-year age groups from age 10-75, the ratios of the proportion of persons and deaths in Egypt to the proportions found in the stable

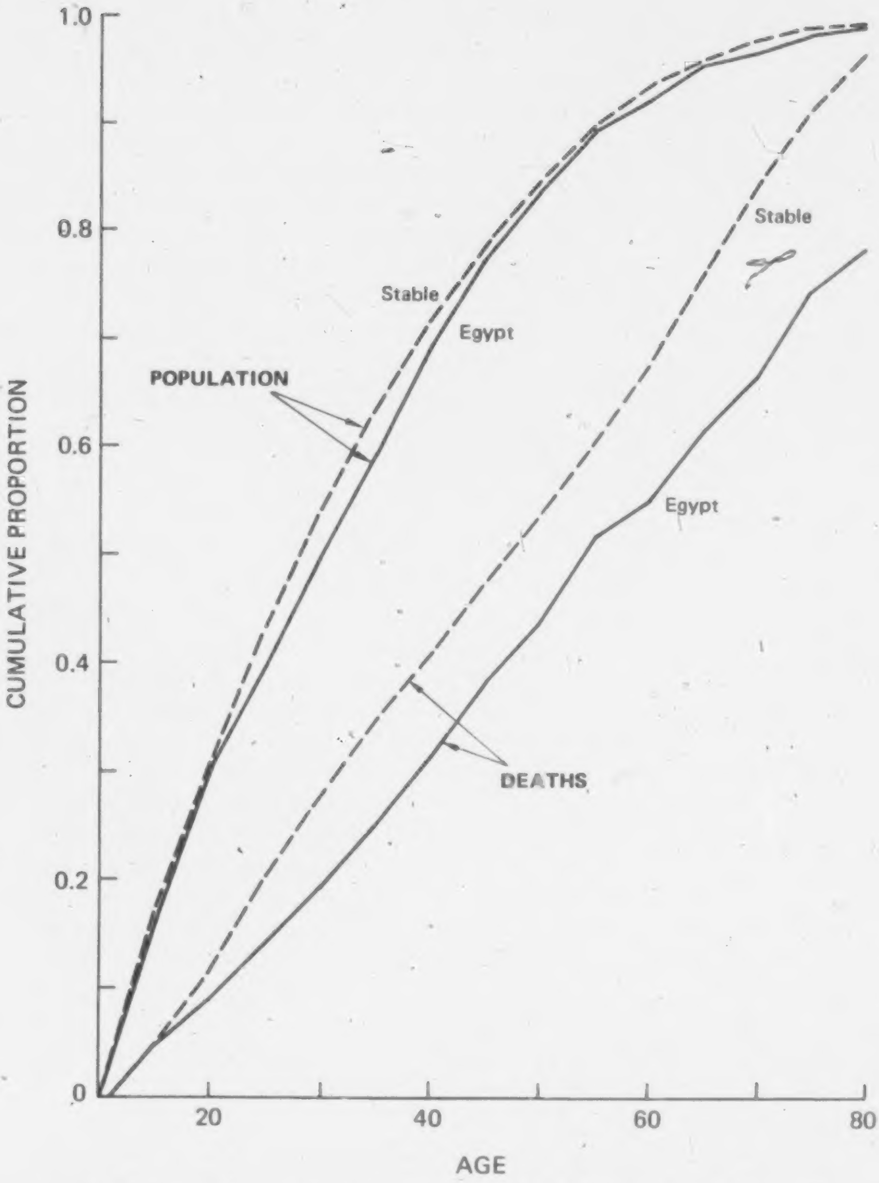


FIGURE C.2 Cumulative Proportionate Distribution of Population and Deaths at Ages 10 and Over, Males, 1941-42, and for a "South" Model Stable Population: Egypt

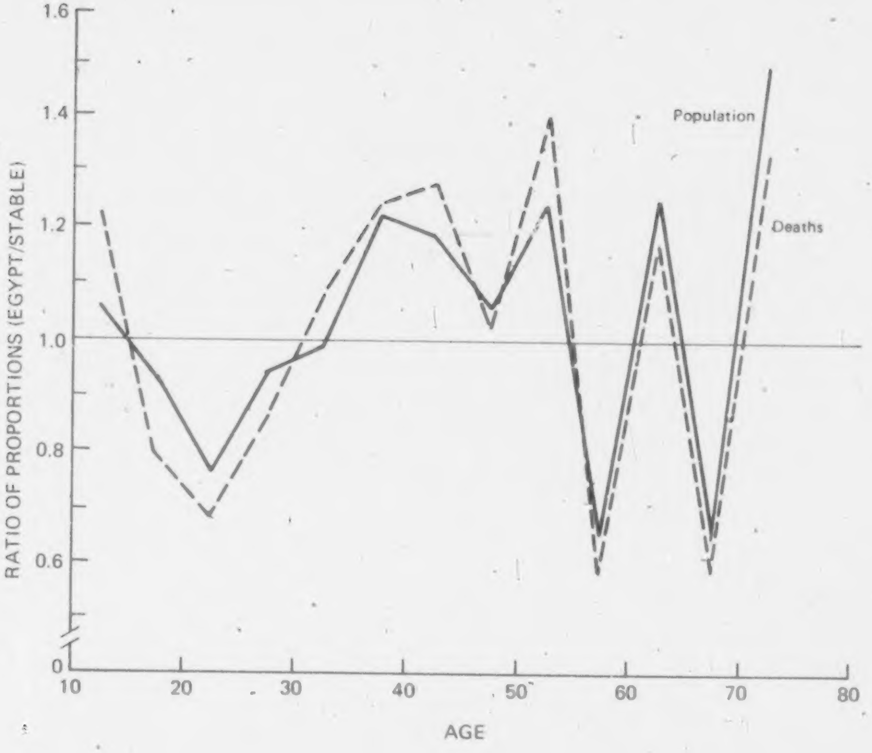


FIGURE C.3 Proportion of Population and Deaths Within the Age Interval 10 to 75 in each Five-Year Age Group Divided by the Corresponding Proportion in a Model Stable Population, Males, 1941-42: Egypt

population. The similarity of the deviations of the proportions of persons and of deaths from the stable is very evident. Apparently the same distortions--primarily the effect of age misreporting--affect the recording of persons in the census and of deaths in the register. The deviations are, however, generally somewhat greater for the reported distribution of deaths. The similarity of the patterns offers no basis for believing that age at death is consistently overstated to a greater extent than age of living persons between the ages of 10 and 75. (There is a slight extra deficit in the distribution of deaths from 50 to 75, relative to the distribution of the population, but surely not enough to account for the very large excess in the proportion of deaths over 75.) Thus, we are left with the possibility that in some way age at death is reported as above 75 or 80 for decedents whose true age is very much less.

How can there be about three times too many deaths recorded at ages over 75 when there is no special pattern of apparent omission in the preceding 25 years? A possible explanation of the large excess number of deaths reported at very advanced ages is the allocation to the oldest ages of deaths at all ages (except infancy and childhood) in which the age of the decedent is unknown. The very extensive age heaping in Egyptian censuses and the repetitive pattern from census to census of distorted age distributions by five-year intervals make it evident that age is not known for a large fraction of the Egyptian population. It seems probable that ages of the dead are known even less frequently than ages of the living; the greater departures of the distribution of deaths than the distribution of the living from the stable distribution from ages 10 to 75 (Figure C-3) lends some support to this conjecture. Yet the proportion of deaths recorded as "age unknown" is very small. It appears that registrars feel pressed to avoid an entry of "age unknown"; if the practice has developed of assigning deaths of unknown ages to the modal category for adult deaths, the excess number of deaths reported at the highest ages would be the result of deaths being transferred up from the whole range of ages above childhood.

Provisionally accepting this explanation of the over-reporting of deaths at the highest ages, we estimated the excess at the highest ages by assuming that the proportion of deaths over 70 should be the same as in a "South" model stable population with the same death rate over age 10 and the same rate of increase. This assumption led to estimates that 46.7 percent of male deaths in 1941-42 were improperly reported as occurring over age 70. This fraction of excess deaths was removed from the over-70 age group and transferred to the age range 10-70 by making an appropriate uniform proportioned increase in the number of deaths at each age.

The values of $\hat{N}(a+)/N(a+)$ calculated after these transfers are shown in Figure C-4. The pattern is a convincing vindication of the transfer of deaths from 70+ to 10-70, i.e., for most ages the value of $\hat{N}(a+)/N(a+)$ lies close to the horizontal line $\hat{N}(a+)/N(a+) = 1.0$. The low value of $\hat{N}(70+)/N(70+)$ can be explained by the overstatement of the number of males over 70 in 1937 and 1947. The fraction of the population 10+ that was over

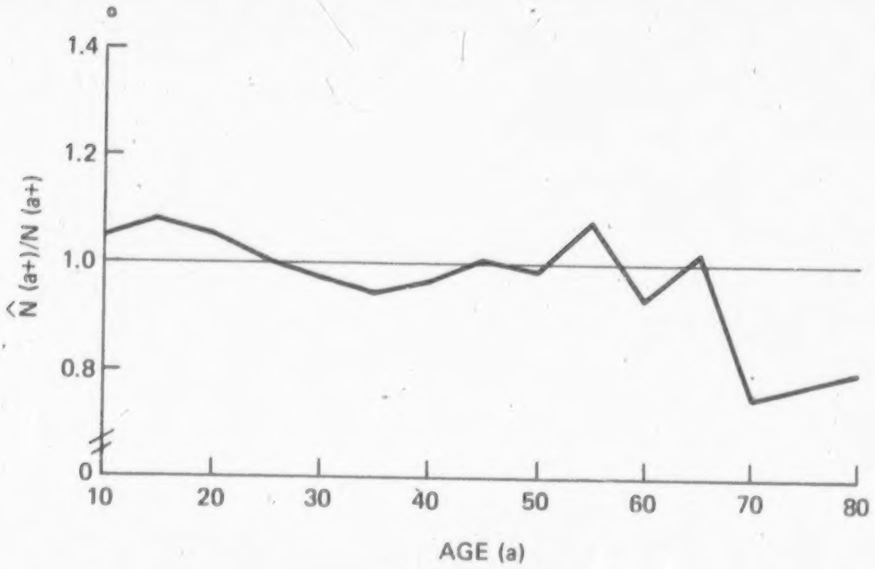


FIGURE C.4 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocation of Excess Deaths at Age 70 and Over, Males, 1941-42: Egypt

70 is 1.8 percent in the stable population, and 3.0 percent in the average of the 1937 and 1947 censuses. After the deaths at ages 70+ have been corrected for overstatement, the number of persons aged 70+ estimated from the deaths falls short of the overstated number recorded in the censuses.

With this clue about the erroneous transfer of age at death at hand, we established a procedure for reallocating wrongly reported deaths from 70+ to the age range 10 to 70. For each year an estimate of the growth rate of the adult population was established, namely, the average rate of natural increase of the whole population during a period 5 to 15 years earlier. The rate of natural increase was taken from El-Badry's adjusted figures of birth and death rates for 1934 to 1959 (El-Badry, 1965). Rates of natural increase were estimated for earlier and later years by assuming that the understatement of birth and death rates prior to 1934 was as in the earliest years of El-Badry's estimates, and after 1960 as in the last years of El-Badry's estimates. (The approximate validity of these rates of natural increase is supported by their aggregate agreement with intercensal population increase. A rate of natural increase in each year $\underline{t}$ implies a cumulated increase in T years of

$$e^{\sum_{o}^{T} r(t)}$$

The populations enumerated in 1937, 1947, 1960, and 1976 differ from the populations calculated from the 1927 census and cumulated rates of natural increase by -3.8 percent, 0.5 percent, 1.2 percent, and 2.3 percent respectively.)

The next step was to determine, by interpolation between censuses, the approximate ratio (persons (10-50))/(persons (10+)) for males and females each year. Then a model stable population ("South" family) was found embodying this ratio of ${}_{40}P_{10}/P(10+)$ and the estimated rate of increase. The ratio of deaths 70+ to deaths 10+ in this stable population was assumed to be the correct proportion. The recorded number of deaths at age 70+ in excess of this fraction was added pro rata to the deaths at each five-year age interval 10-14 to 65-69. Then $\hat{N}(a+)$ was calculated from these reassigned deaths as follows (Preston et al., 1980):

(1) $\hat{N}(70) = D(70+)(1 + r \cdot e(70))$, where $e(70)$ is the expectation of life at age 70 in the model life table selected on the basis of r and ${}_{40}P_{10}/P(10+)$

(2) $\hat{N}(70+) = \hat{N}(70)e(70)(1 - \frac{2r}{3} e(70))$

(3) $\hat{N}(a) = \hat{N}(a + 5)\exp(5r) + {}_{5}D_{a}\exp(2.5r)$, for a = 65, 60, 55, . . . , 10; where ${}_{5}D_{a}$ is the number of registered deaths from age a to $a + 5$

(4) ${}_{5}\hat{N}_{a} = 2.5(\hat{N}(a) + \hat{N}(a+5))$

(5) $\hat{N}(a+) = \sum_{x=a}^{65} {}_{5}\hat{N}_{x} + \hat{N}(70+)$

In Table C-1, the following quantities are listed for each year 1937 to 1976, for males and females: the proportion ${}_{40}P_{10}/P(10+)$; the rate of natural increase, r; the expectation of life at age 10 and at age 70 in the stable population chosen by means of these quantities; and the ratio of deaths at ages 70+ to deaths at ages 10+ as registered and as in the stable population. The last two quantities determine how many deaths are transferred from the 70+ category to the ages from 10 to 70.

The apparent excess proportion of deaths recorded as occurring at ages over 70 is shown in Figure C-5. The ratios (recorded proportion)/(estimated proportion) follow more or less parallel curves for males and females. By this calculation, the proportion of female deaths recorded as over age 70 was more than double the correct proportion from 1937 to 1956 (with the exception of 1947); for the same years the proportion of male deaths was at least 1.75 times the proportion calculated as correct. From the mid 1950s to the early 1960s, overstatement of the proportion of female deaths over age 70 declined from 2.0 times to about 1.5 times the calculated correction proportion; overstatement of the proportion of male deaths over age 70 had apparently been eliminated by the mid 1960s.

Indeed from 1966 to 1974 the calculations imply too small a proportion of male deaths at the higher ages. This anomaly illustrates the limitations of the procedure for estimating the correct distribution of deaths. It is unlikely that too small a proportion of male deaths were recorded as over 70, while the proportion of female deaths over 70 continued to be overstated by a large margin. The model distribution of deaths by age is doubtless somewhat inappropriate in particular periods because the age distribution is not truly stable, because the rate of increase employed is possibly not the proper one, or because the pattern of mortality in Egypt does not follow the "South" model very closely. In our estimation of mortality past age 5, a uniform adjustment for underregistration is applied each year in the period 1960 to 1976 (no adjustment for male deaths, multiplication by 1.18 for females); the values for expectation of life at age 5 and age 10 are from a "South" model table that yields the adjusted death rate over 10. In other words, the anomalous indications of too low a proportion of reported deaths over 70, and the associated indications of over-registered deaths, do not enter the calculations.

In Figure C-6, the values of $\hat{N}(a+)/N(a+)$ calculated as described above are plotted for selected years. Once the apparent excess proportion of deaths over 70 has been corrected by a transfer to younger ages, $\hat{N}(a+)/N(a+)$ no longer indicates a high degree of overregistration (in most years), nor does it any longer rise with age to very high values at older ages. Instead, there is a remarkably similar pattern from year to year, with slightly higher and lower values at the same ages, but with different overall levels from year to year.

1976 Rural Areas			
Cairo	--	--	-
Alexandria	--	--	-
Lower Egypt			
Damietta	37.2	165.0	5.
Dakahlia	37.7	168.3	5.
Sharkia	40.4	185.3	6.
Kalyubia	42.0	196.8	6.
Kafr-el-Sheik	40.7	177.1	5.
Gharbia	37.2	165.8	5.
Menoufia	38.6	180.8	6.
Behera	40.5	183.3	6.
Upper Egypt			
Giza	49.9	230.0	7.
Beni Suef	46.1	208.1	6.
Fayoum	48.7	230.8	7.
Minya	49.1	221.3	7.
Assyiut	45.8	211.4	7.
Souhag	40.0	175.3	5.
Kena	42.2	183.2	6.
Aswan	42.4	179.7	6.
Egypt	42.6	192.2	6.

Note: Ismailia Governorate not included; data n
indexes.

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0.429	0.616	0.697	.226
0.451	0.643	0.702	.224
0.496	0.706	0.704	.218
0.528	0.772	0.684	.213
0.468	0.725	0.646	.230
0.444	0.681	0.652	.224
0.491	0.711	0.691	.214
0.485	0.688	0.705	.221
0.601	0.770	0.781	.217
0.562	0.740	0.760	.222
0.617	0.791	0.780	.211
0.592	0.804	0.736	.222
0.569	0.759	0.750	.217
0.470	0.699	0.673	.228
0.491	0.640	0.767	.230
0.486	0.666	0.729	.236
0.506	0.712	0.711	.222

available to calculate most measures and

TABLE C-1 Measures Used in Reallocation of Excess Deaths at Age 70 and Over: Egypt

	$\frac{{}_{40}P_{10}}{P_{10+}}$	r	$\dot{e}_{10}^{a}$	e_{70}^{a}	Registered $\frac{D_{70+}}{D_{10+}}$	Stable Population $\frac{D_{70+}}{D_{10+}}$
Males						
1937	.8384	.0173	45.41	7.27	.3297	.1885
1938	.8384	.0172	45.32	7.25	.3338	.1876
1939	.8384	.0169	45.08	7.21	.3302	.1851
1940	.8384	.0166	44.87	7.18	.3350	.1834
1941	.8384	.0164	44.70	7.15	.3250	.1819
1942	.8384	.0163	44.60	7.14	.3308	.1811
1943	.8384	.0163	44.57	7.13	.3260	.1808
1944	.8384	.0162	44.53	7.12	.3177	.1804
1945	.8384	.0157	44.08	7.05	.3128	.1761
1946	.8384	.0154	43.83	7.01	.3060	.1736
1947	.8384	.0149	43.45	6.95	.2730	.1706
1948	.8375	.0144	43.19	6.90	.3181	.1693
1949	.8367	.0143	43.29	6.92	.3219	.1711
1950	.8358	.0143	43.45	6.94	.3526	.1732
1951	.8350	.0144	43.67	6.98	.3663	.1759
1952	.8341	.0150	44.30	7.09	.3602	.1829
1953	.8332	.0156	44.90	7.18	.3685	.1892
1954	.8324	.0161	45.48	7.28	.3783	.1959
1955	.8315	.0171	46.54	7.45	.3820	.2074
1956	.8307	.0182	47.69	7.64	.3884	.2205
1957	.8298	.0200	49.65	7.94	.4043	.2438
1958	.8290	.0211	51.13	8.16	.3951	.2634
1959	.8281	.0222	52.55	8.38	.4091	.2838
1960	.8270	.0230	53.72	8.58	.4022	.3027
1961	.8272	.0238	54.64	8.73	.4044	.3170
1962	.8274	.0236	54.34	8.68	.3627	.3116
1963	.8276	.0238	54.56	8.72	.3599	.3151
1964	.8278	.0244	55.17	8.82	.3586	.3247
1965	.8281	.0245	55.25	8.83	.3271	.3256
1966	.8283	.0248	55.56	8.89	.3173	.3309
1967	.8285	.0244	55.03	8.80	.3020	.3214
1968	.8287	.0248	55.49	8.88	.2977	.3290
1969	.8289	.0250	55.67	8.91	.2932	.3320
1970	.8291	.0255	56.27	9.02	.3111	.3421
1971	.8294	.0256	56.36	9.03	.3068	.3435
1972	.8296	.0261	56.91	9.14	.3243	.3537
1973	.8298	.0259	56.56	9.07	.3283	.3466
1974	.8300	.0255	55.98	8.97	.3225	.3359
1975	.8302	.0248	55.14	8.82	.3173	.3209
1976	.8308	.0242	54.34	8.68	.3199	.3077

TABLE C-1 (continued)

	$\frac{{}_{40}P_{10}}{P_{10+}}$	r	e_{10}^{a}	e_{70}^{a}	Registered $\frac{D_{70+}}{D_{10+}}$	Stable Population $\frac{D_{70+}}{D_{10+}}$
Females						
1937	.8229	.0173	47.15	7.49	.4695	.2282
1938	.8230	.0172	47.01	7.46	.4804	.2266
1939	.8231	.0169	46.70	7.40	.4798	.2232
1940	.8232	.0166	46.46	7.35	.4920	.2202
1941	.8233	.0164	46.25	7.31	.4836	.2176
1942	.8235	.0163	46.13	7.29	.4938	.2160
1943	.8236	.0163	46.07	7.28	.4701	.2151
1944	.8237	.0162	46.00	7.26	.4620	.2142
1945	.8238	.0157	45.45	7.16	.4634	.2085
1946	.8239	.0154	45.15	7.10	.4615	.2052
1947	.8241	.0149	44.72	7.02	.3987	.2001
1948	.8236	.0144	44.37	6.95	.4777	.1968
1949	.8231	.0143	44.40	6.95	.4758	.1977
1950	.8226	.0143	44.49	6.97	.4935	.1992
1951	.8221	.0144	44.66	7.00	.4988	.2017
1952	.8216	.0150	45.27	7.13	.4947	.2092
1953	.8211	.0156	45.87	7.24	.5051	.2157
1954	.8206	.0161	46.42	7.35	.5221	.2228
1955	.8201	.0171	47.50	7.55	.5262	.2357
1956	.8196	.0182	48.67	7.78	.5414	.2503
1957	.8190	.0200	50.68	8.16	.5533	.2779
1958	.8185	.0211	52.21	8.42	.5483	.3001
1959	.8180	.0222	53.69	8.68	.5576	.3234
1960	.8173	.0230	54.86	8.91	.5401	.3438
1961	.8178	.0238	55.82	9.09	.5580	.3598
1962	.8183	.0236	55.43	9.01	.5402	.3520
1963	.8187	.0238	55.61	9.05	.5504	.3546
1964	.8192	.0244	56.21	9.17	.5543	.3651
1965	.8197	.0245	56.22	9.17	.5432	.3647
1966	.8201	.0248	56.52	9.23	.5453	.3693
1967	.8206	.0244	55.87	9.10	.5367	.3567
1968	.8211	.0248	56.31	9.19	.5271	.3642
1969	.8215	.0250	56.45	9.21	.5330	.3660
1970	.8220	.0255	57.03	9.33	.5568	.3762
1971	.8225	.0256	57.07	9.34	.5450	.3763
1972	.8230	.0261	57.59	9.45	.5559	.3862
1973	.8234	.0259	57.15	9.36	.5555	.3766
1974	.8239	.0255	56.46	9.22	.5382	.3628
1975	.8244	.0248	55.49	9.02	.5311	.3443
1976	.8247	.0242	54.55	8.84	.5271	.3280

[a] Expectation of life in South Model Stable Population chosen on the basis of ${}_{40}P_{10}/P_{10+}$ and r.

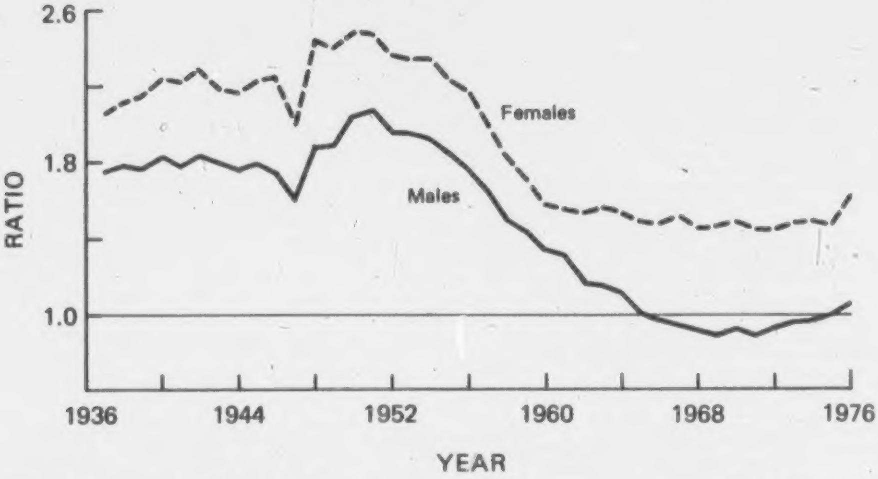


FIGURE C.5 Ratio of the Recorded Proportion of Deaths Over Age 70 to the Estimated Proportion of Deaths Over Age 70, Males and Females, 1937-76: Egypt

The common pattern of the sequence can be explained by the tendency for $\hat{N}(a+)$ (as calculated) to approximate the structure of $N(a+)$ in the stable population used to determine the correct proportion of deaths over 70, and by the consistent resemblance of the Egyptian age distribution, (especially the distribution above age 10), to a stable population. Note in Table C-1 the limited change from year to year in the ratio ${}_{40}P_{10}/P(10+)$; as lower mortality produced a tendency for the age distribution to fall less rapidly with age, a higher rate of increase had an offsetting tendency to make the distribution steeper. Overall, the steepness remains almost constant.

When the number of deaths is redistributed so that the proportion of deaths over 70 to those over 10 matches the proportion in a stable population, the cumulative distribution of deaths over 10 is forced into rough agreement with the cumulative distribution of deaths in the stable population. When $\hat{N}(a+)$ is calculated from this adjusted distribution of deaths and the rate of increase of the stable population, the distribution of $\hat{N}(a+)$ is bound to have a general resemblance to the stable age distribution. Recall that the distribution of deaths within the age interval 10 to 70 in 1941-42 bore much the same relation to the stable distribution of deaths as the distribution of population in the same interval bore to the stable age distribution (Figure

C-3). Since $\hat{N}(a+)$ is the cumulation of $\hat{N}(x)$ above age a, the bumps and hollows in the distribution of deaths are smoothed out. Thus each year the structure of $\hat{N}(a+)$ is more or less constrained to resemble a stable age distribution with the current ${}_{40}P_{10}/P(10+)$ and thus bears a more or less fixed relation to the age distribution of the population.

Note that the slight ups and downs of $\hat{N}(a+)/N(a+)$ for different years have a very similar structure, but that the variation with age becomes less over time from 1937 to 1976. The reason is that $\hat{N}(a+)/N(a+)$ departs from a level track primarily because $N(a+)$ deviates from a stable population as age misreporting distorts the distributions reported in the censuses. The pattern of such misreporting remains about the same from census to census but becomes less severe in the more recent censuses.

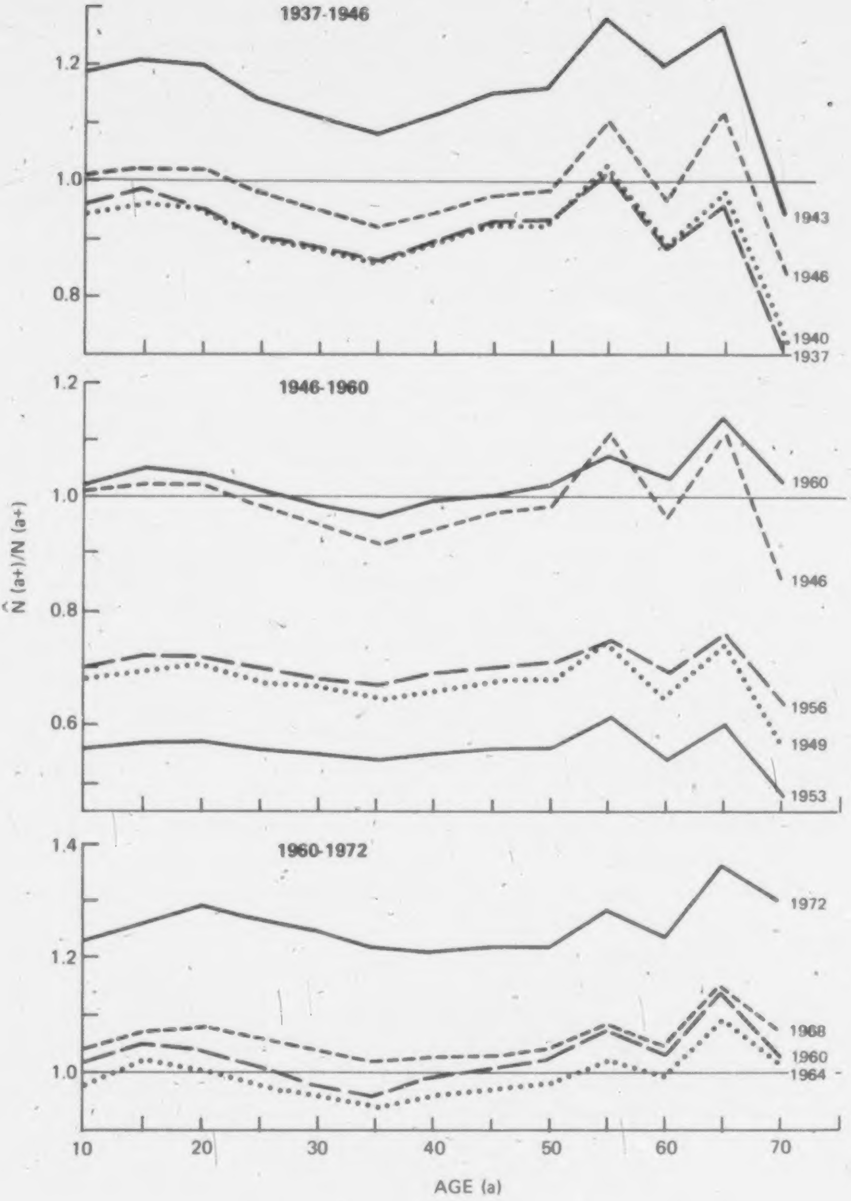
Although reassignment of deaths from 70+ to other ages more or less insures that the sequence of $\hat{N}(a+)/N(a+)$ is much more nearly level than it is without reassignment, the height of the nearly level sequence still depends on the number of registered deaths relative to the number of persons in the population. The height of the plateau of $\hat{N}(a+)/N(a+)$ can be accepted as an estimate of the completeness of death registration relative to the completeness of enumeration of the population.

Figure C-7 shows the value of $\hat{N}(10+)/N(10+)$ for each year from 1937 to 1976. (The consistency of the sequences of $\hat{N}(a+)/N(a+)$ from year to year allows us to represent each sequence by the value at age 10.) Note that the male and female sequences are very similar, with the apparent completeness of death registration consistently lower for females.

We can conclude from Figure C-7 that there were three periods with differing characteristic degrees of completeness of death registration. From 1937 to 1946, completeness of registration was high for males (about 95 percent complete) and about 15 percent lower for females. Then from 1947 until 1959, completeness of registration for both sexes deteriorated to about 60 percent for males and less than 50 percent for females. After 1959, there was a recovery, so that from 1960 to 1976 male death registration was essentially complete and female registration about 85 percent complete.

Values of $\hat{N}(10+)/N(10+)$ of more than 1.0 for males in some years in the 1940s and around 1970 require explanation. This system of estimating completeness of

MALES


1937-1946
1.2
1.0
0.8
1943
1946
1940
1937
1946-1960
1.2
1.0
0.8
0.6
1960
1946
1956
1949
1953
1960-1972
1.4
1.2
1.0
1972
1968
1960
1964
10
20
30
40
50
60
70
AGE (a)
$\hat{N}(a+)/N(a+)$

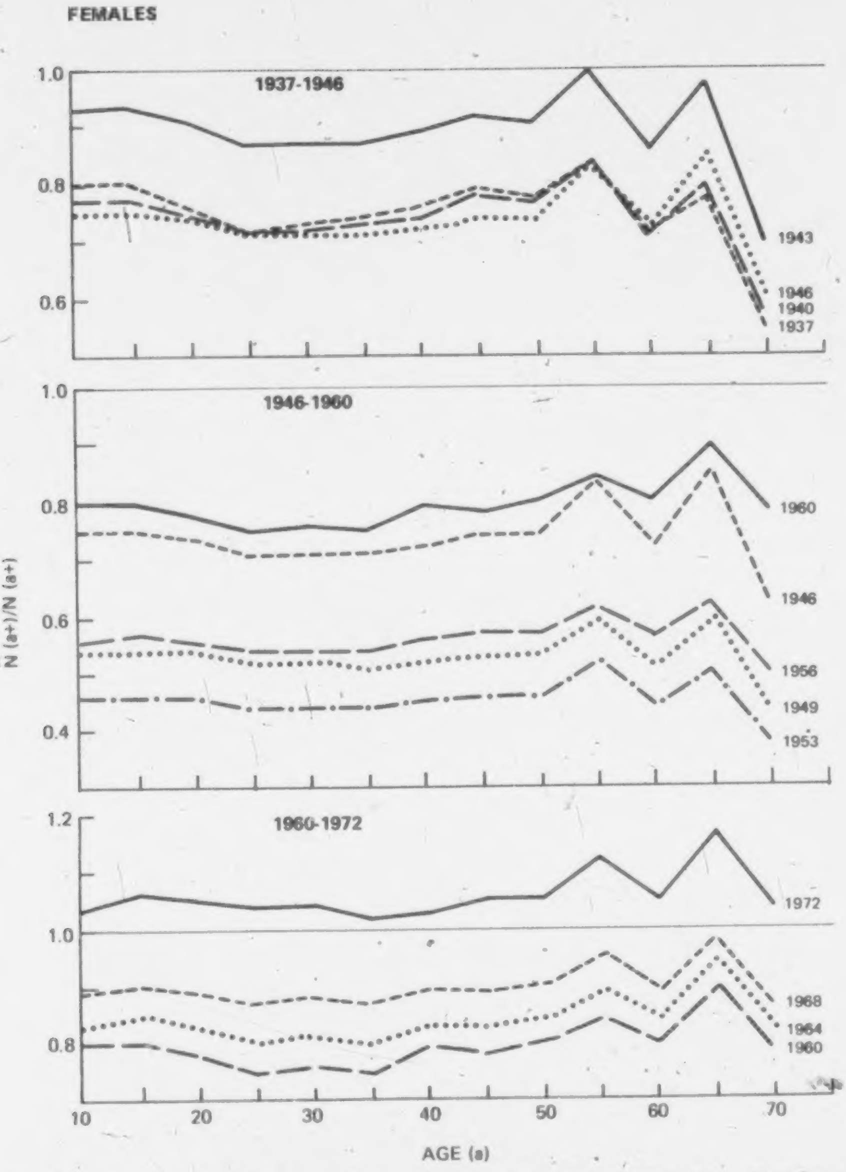


FIGURE C.6 Completeness of Death Registration Estimated by Comparison of Deaths and Population at Age (a) and Over, After Reallocaton of Excess Deaths at Age 70 and Over, Males and Females, Selected Years: Egypt

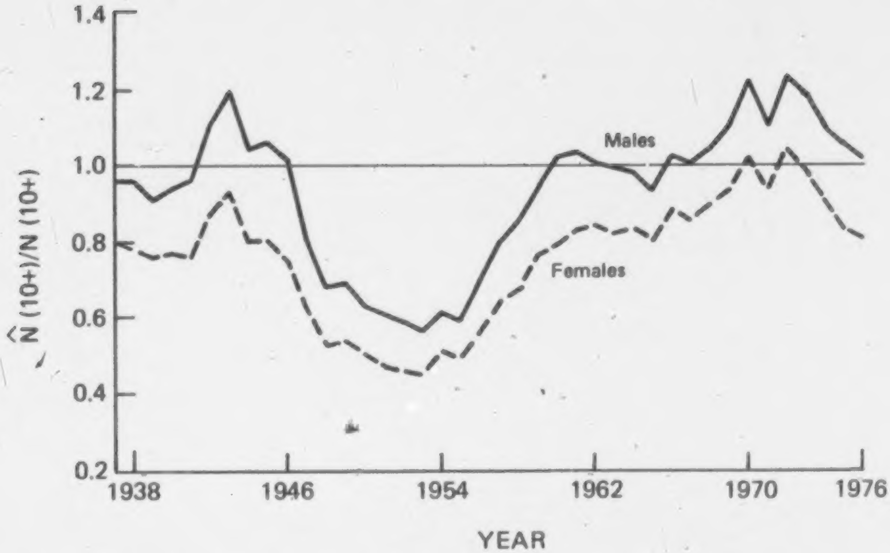


FIGURE C.7 Estimated Completeness of Death Registration at Age 10+ by Sex, 1937-76: Egypt

registration proceeds by determining the size of cohorts implied by registered deaths, on the assumption that the correct age structure and current mortality are consistent, in the sense that both could belong to the same stable population. Over a period of years this assumption is approximately valid, when fertility has been about constant, as in Egypt. However, in a particular year when an epidemic or a poor crop may raise the death rate at all ages, the mortality schedule is not consistent with the age distribution and the average rate of increase. In a year of episodic high mortality, values of $\hat{N}(a+)$ systematically exceed values of $N(a+)$. We interpreted the high values of $\hat{N}(a+)$ in 1942 and 1943, for example, as the result of a temporary increase in the death rate. It would surely be inappropriate to assume that there was overregistration in those years, and to estimate the true number of deaths as well below the registered number. (However, the possibility of overregistration cannot be ruled out altogether; the number of registered marriages also reaches a peak in these years, and the source of some of the high rates may be delayed registration of events that occurred earlier.)

The dip to greatly reduced estimated completeness of registration in the 1950s almost certainly resulted from a genuine deterioration in the recording of deaths. The recorded death rate over age 10 fell very precipitously in the late 1940s, and then rose to former levels in the late 1950s. The low mortality rates in this period are not believable. In Figure C-8, the expectation of life at age 10, e(10), is shown as estimated three ways: first, from a "South" stable population with Egypt's population ratio ${}_{40}P_{10}/P(10+)$ and estimated growth rate; second, from a "South" stable population with Egypt's registered death rate over age 10 and estimated r; and third, from a "South" stable population with Egypt's estimated r and death rate over age 10 adjusted for underregistration. If there is no correction for underregistration, the estimates of e(10) for males and females rise to incredible levels by the early 1950s--approximating or bettering mortality in present-day Sweden--only to fall back to much lower values. On the other hand, the estimates based on the adjusted death rate follow, in a general way, the mortality implied by the age distribution and rate of population growth and are much more in accord with common sense.

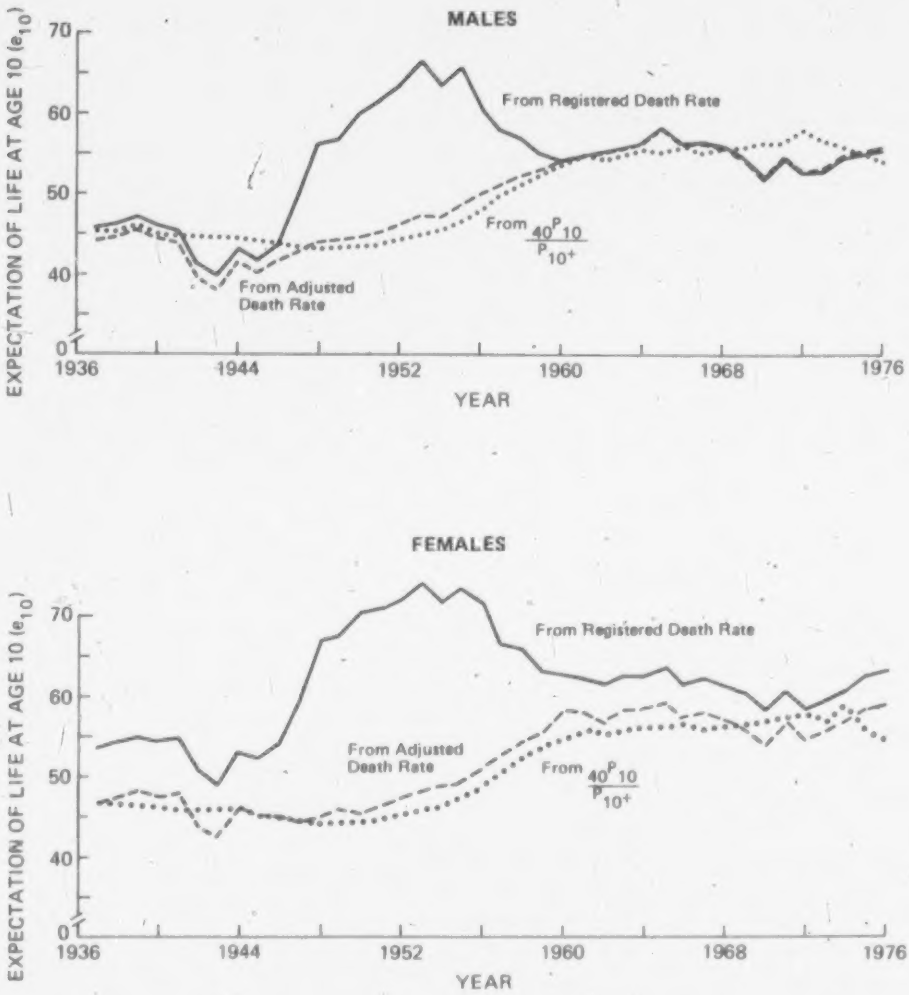


FIGURE C.8 Expectation of Life at Age 10 (e_{10}) from "South" Model Stable Populations as Implied by the Estimated Growth Rate and (1) the Ratio of the Population Aged 10 and Over, (2) the Registered Death Rate at Age 10+, and (3) the Adjusted Death Rate at Age 10+, Males and Females, 1937-76 : Egypt

Appendix D

Reconstruction of Egyptian Population Projection, 1927-77

The creation of estimates of births, infant mortality, and completeness of registration of adult mortality in Egypt from 1927 to 1976 (as summarized in Table 2 and Figure 2 in Chapter 2) provides the basis for projecting the population, by standard techniques, from 1927 to 1977. The projected population (interpolated to census dates) can be compared with the enumerated populations to determine whether estimated fertility and mortality are consistent with the increase in the population as recorded in the censuses and with the evolution of the age and sex composition of the population that the censuses indicate. The censuses cannot be taken as standards that the projected population should match, because the age distribution of the enumerated population at each census is strongly affected by age misreporting, and possibly by underenumeration that may be age- and sex-selective and may be more severe in some censuses than in others.

LIFE TABLES FOR PROJECTING THE POPULATION

The life tables used for projection are a composite, with ℓ_5/ℓ_0 and ${}_5L_0$ determined by the estimated infant mortality rate for the period in question, and ℓ_x, ${}_5L_x$, and T_x values (as needed) relative to ℓ_5 determined by the adjusted death rate over age 10 for each sex, and the rate of increase of the population aged 10 and over. In other words, for each sex, a full life table was formed by splicing survival rates over age 5, derived from corrected registered deaths over age 10, to survival rates under age 5 based on corrected infant mortality. A level of mortality was found in the "West" family of model life tables such that ${}_1q_0$ for the two sexes combined matched the corrected infant mortality rate for each year (Appendix A); ℓ_5 and ${}_5L_0$ for each sex were taken from this level. A significant feature of this procedure was the acceptance of the sex differences in mortality under age 5 in the "West" model life tables as characteristic of Egypt.

Life table values above age 5 were determined independently for each sex. Deaths over age 10 were corrected for underregistration; then a "South" model life table was chosen that would produce the corrected death rate over age 10 in a stable population growing at the rate estimated for the population over 10.

The life tables for the population projection incorporated average mortality over five-year time periods (1927-31, 1932-36, . . . , 1972-76) based on average corrected IMR for each five-year period, average corrected death rates for age 10+, and average estimated rates of increase.

Births for the Projection

The population under age 5 at the end of each quinquennial time period was calculated from the estimated number of births during the period multiplied by ${}_5L_0/5 \cdot \ell_0$ from the life table for the interval. The estimated number of births, as described in Appendix B, were divided into male and female births under the assumption that each year 51.46 percent of the births were male. For the period 1948 through 1959, for which no sound basis for estimating completeness of birth registration could be established, it was assumed that the annual number of births increased at a constant geometric rate from the number estimated for 1947 to the number estimated for 1960.

Initial Population and Calculation Procedures for the Projection

The projection, extending from 1927 to 1977, begins with the population enumerated in the 1927 census. Age distributions recorded in all of the Egyptian censuses are quite evidently distorted, so to accept the 1927 age distribution as reported would be to initiate the projection with numbers that are clearly too small for some age groups and clearly too large for others. Therefore, a stable population for each sex was calculated. The stable age distribution for each sex incorporated the life table constructed for 1927, and a growth rate (common to the two sexes) that yielded a birth rate of 49.3 per thousand for the two sexes combined. (A growth rate of 17.8 per thousand was required.)

The projection to 1932 and ensuing years at five-year intervals was then carried out by the conventional multiplication of the number in each five-year age interval (${}_5P_x$) by the appropriate life table survival rate (${}_5L_{x+5}/{}_5L_x$). The projected population under age 5 was filled in by calculating the number of survivors of the estimated births during each quinquennial interval.

To provide a comparison between the projected population and the population enumerated in the ensuing censuses, the projections (to February of each year in the series since the 1927 census was in February) were interpolated to the census dates.

Projection Results

Table D-1 presents the projected population by sex and five-year age intervals for 1927 to 1977. (In 1927, the "projected" population is the initial stable population described earlier.) Interpolated populations for 1960 and 1976 are also listed in the table.

The projected male population exceeds the enumerated population in 1937 by 3.6 percent, in 1947 by 1.2 percent, in 1960 by 0.8 percent, and in 1976 by 4.9 percent. (Corresponding figures for females are 1937, 4.2 percent; 1947, 1.3 percent; 1960, 2.6 percent; and 1976, 7.8 percent.) From 1927 to 1960 the average intercensal rate of increase was 18.1 per thousand; the average rate of increase of the projected population was 17.6 per thousand. The agreement between the projection and the census totals is very close in 1947 and 1960 (within about 1 percent for males). But since the 1937 census falls short of the projected population by about 4 percent only ten years after the projection starts, one may suppose that the 1937 census was an undercount. The 1976 census is some 6 percent below the projected figure. However, the official estimate of Egyptians residing abroad in 1976 is 1.425 million. The projection cannot

TABLE D-1 Projected Population by Sex and Five-Year Age Groups at Five-Year Intervals and the 1960 and 1976 Census Dates, 1927 to 1977: Egypt

	1927		1932	
Age Group	Males	Females	Males	Females
0-4	1,150,677	449,134	1,260,896	1,247,568
5-9	912,680	912,116	996,608	996,200
10-14	805,114	801,973	876,950	872,547
15-19	715,124	709,558	779,466	773,142
20-24	625,910	621,273	680,921	676,273
25-29	542,413	540,463	589,802	587,584
30-34	469,926	468,126	511,016	509,365
35-39	405,769	404,831	441,270	439,814
40-44	347,328	348,799	377,376	379,197
45-49	293,192	299,387	318,487	325,518
50-54	242,657	253,678	263,258	275,595
55-59	194,591	208,966	210,533	226,814
60-64	147,655	163,328	159,126	176,209
65-69	102,130	116,266	109,688	124,576
70-74	61,264	71,554	65,172	75,841
75-79	29,362	34,745	30,669	36,469
80+	12,563	15,308	12,911	15,686
All Ages	7,058,073	7,119,791	7,684,143	7,738,388

	1937		1942	
Age Group	Males	Females	Males	Females
0-4	1,318,500	1,300,933	1,403,607	1,383,420
5-9	1,097,115	1,085,259	1,156,545	1,146,740
10-14	951,954	945,798	1,056,866	1,047,108
15-19	845,248	836,224	923,407	917,878
20-24	737,200	731,292	807,168	803,881
25-29	636,382	634,038	697,147	698,479
30-34	551,225	548,697	601,602	603,791
35-39	476,012	474,002	519,412	521,075
40-44	406,747	408,036	444,409	448,810
45-49	342,589	350,545	374,596	384,888
50-54	282,683	296,448	309,142	326,610
55-59	225,200	242,937	246,763	269,292
60-64	168,860	187,162	185,688	209,865
65-69	114,912	129,842	126,963	148,271
70-74	67,153	77,086	74,627	89,652
75-79	30,695	35,657	34,489	42,756
80+	12,689	15,138	13,677	17,267
All Ages	8,265,157	8,299,089	8,976,098	9,059,772

TABLE D-1 (continued)

	1947		1952	
Age Group	Males	Females	Males	Females
0-4	1,449,348	1,429,896	1,856,537	1,817,193
5-9	1,216,152	1,208,818	1,296,879	1,280,414
10-14	1,098,368	1,096,053	1,169,811	1,158,721
15-19	1,014,319	1,008,785	1,064,252	1,058,298
20-24	867,670	874,076	967,017	963,414
25-29	748,365	759,530	818,861	828,593
30-34	646,500	657,597	706,078	717,583
35-39	556,056	566,645	607,980	619,377
40-44	474,639	487,543	517,992	532,118
45-49	399,513	418,406	436,035	456,150
50-54	328,787	353,860	359,491	386,245
55-59	260,823	291,540	286,011	317,574
60-64	194,204	226,517	214,043	247,243
65-69	130,404	159,428	145,014	174,321
70-74	74,584	96,125	83,840	105,403
75-79	33,019	45,265	37,748	49,992
80+	13,224	18,636	14,383	20,409
All Ages	9,505,967	9,698,716	10,581,964	10,733,040

	1957		1960	
Age Group	Males	Females	Males	Females
0-4	2,067,944	2,021,706	2,286,583	2,229,116
5-9	1,678,134	1,644,301	1,841,400	1,804,533
10-14	1,259,821	1,240,236	1,540,216	1,510,900
15-19	1,141,877	1,127,859	1,213,666	1,196,083
20-24	1,025,949	1,021,262	1,091,216	1,081,916
25-29	925,056	924,222	978,033	977,033
30-34	782,808	792,701	866,850	870,400
35-39	672,819	684,730	734,633	747,350
40-44	574,709	589,260	627,316	642,750
45-49	483,742	504,312	529,866	550,583
50-54	399,834	427,285	438,700	467,133
55-59	320,028	353,361	352,966	388,116
60-64	242,202	277,284	270,666	309,250
65-69	167,245	199,158	190,649	226,950
70-74	99,533	123,355	117,058	145,933
75-79	46,608	60,594	57,278	75,220
80+	17,749	24,834	22,644	32,253
All Ages	11,906,051	12,016,456	13,159,740	13,255,519

TABLE D-1 (continued)

	1962		1967	
Age Group	Males	Females	Males	Females
0-4	2,373,279	2,311,422	2,625,139	2,549,909
5-9	1,906,309	1,868,270	2,214,496	2,160,171
10-14	1,651,260	1,618,485	1,886,597	1,846,967
15-19	1,241,674	1,222,604	1,634,938	1,601,251
20-24	1,117,063	1,106,307	1,223,249	1,204,851
25-29	999,041	998,097	1,097,024	1,087,010
30-34	899,588	901,484	979,621	978,993
35-39	758,777	771,612	879,425	882,549
40-44	648,051	664,461	737,791	753,102
45-49	547,995	569,369	624,499	645,723
50-54	454,149	482,766	520,693	548,570
55-59	366,202	402,093	422,051	458,114
60-64	281,560	321,889	328,571	370,877
65-69	199,818	238,345	238,846	381,981
70-74	123,936	154,880	153,987	190,516
75-79	61,519	81,041	80,818	105,727
80+	24,641	35,166	35,305	50,225
All Ages	13,654,856	13,748,285	15,683,044	15,716,532

	1972		1976	
Age Group	Males	Females	Males	Females
0-4	2,600,271	2,522,956	2,873,304	2,774,374
5-9	2,452,246	2,384,062	2,448,377	2,379,134
10-14	2,185,158	2,128,791	2,408,488	2,341,524
15-19	1,863,580	1,822,516	2,148,590	2,093,215
20-24	1,604,894	1,572,658	1,820,625	1,784,047
25-29	1,196,092	1,179,242	1,561,659	1,534,317
30-34	1,071,134	1,061,849	1,162,188	1,148,331
35-39	953,487	954,401	1,037,483	1,031,961
40-44	850,942	857,728	918,050	924,691
45-49	707,099	728,765	811,445	827,452
50-54	589,693	619,152	664,257	696,723
55-59	480,240	517,330	540,992	582,393
60-64	374,827	418,636	424,086	471,898
65-69	274,718	320,322	311,422	361,380
70-74	180,352	220,804	205,962	251,116
75-79	97,661	126,362	113,244	146,940
80+	45,912	64,931	56,240	80,107
All Ages	17,528,240	17,500,480	19,506,612	19,429,603

TABLE D-1 (continued)

	1977	
Age Group	Males	Females
0-4	2,885,567	2,785,952
5-9	2,458,826	2,389,062
10-14	2,418,767	2,351,295
15-19	2,157,760	2,101,950
20-24	1,828,395	1,791,492
25-29	1,568,324	1,540,720
30-34	1,167,148	1,153,123
35-39	1,041,911	1,036,267
40-44	921,968	928,550
45-49	814,908	830,905
50-54	667,092	699,630
55-59	543,301	584,823
60-64	425,896	473,867
65-69	312,751	362,888
70-74	206,841	252,164
75-79	113,928	147,553
80+	56,480	80,441
All Ages	19,589,808	19,510,624

Note: The projection dates are February for each year except the census years 1960 (September) and 1976 (November).

but include these nonresidents. Adding 1.425 million to the resident population leads to an aggregate difference of less than 3 percent between projected and enumerated population, after nearly 40 years of projection. The average annual projected rate of increase for 1927 to 1976 exceeds the average rate of increase of the enumerated population between those years by less than 1 per thousand. Adjusted birth and death rates may be in error, but the differences between them, at least, are very consistent with the recorded growth of the Egyptian population.

In Figures D-1 and D-2, the enumerated population at each age, male and female, is compared with the projected population in the five censuses from 1927 to 1976. (The "projected" population for 1927 is the fitted stable population.) For both sexes, but especially males, a consistent tendency toward undercounting and overcounting in the same age intervals is evident in every census from 1927 to 1976, with a general trend toward reduced

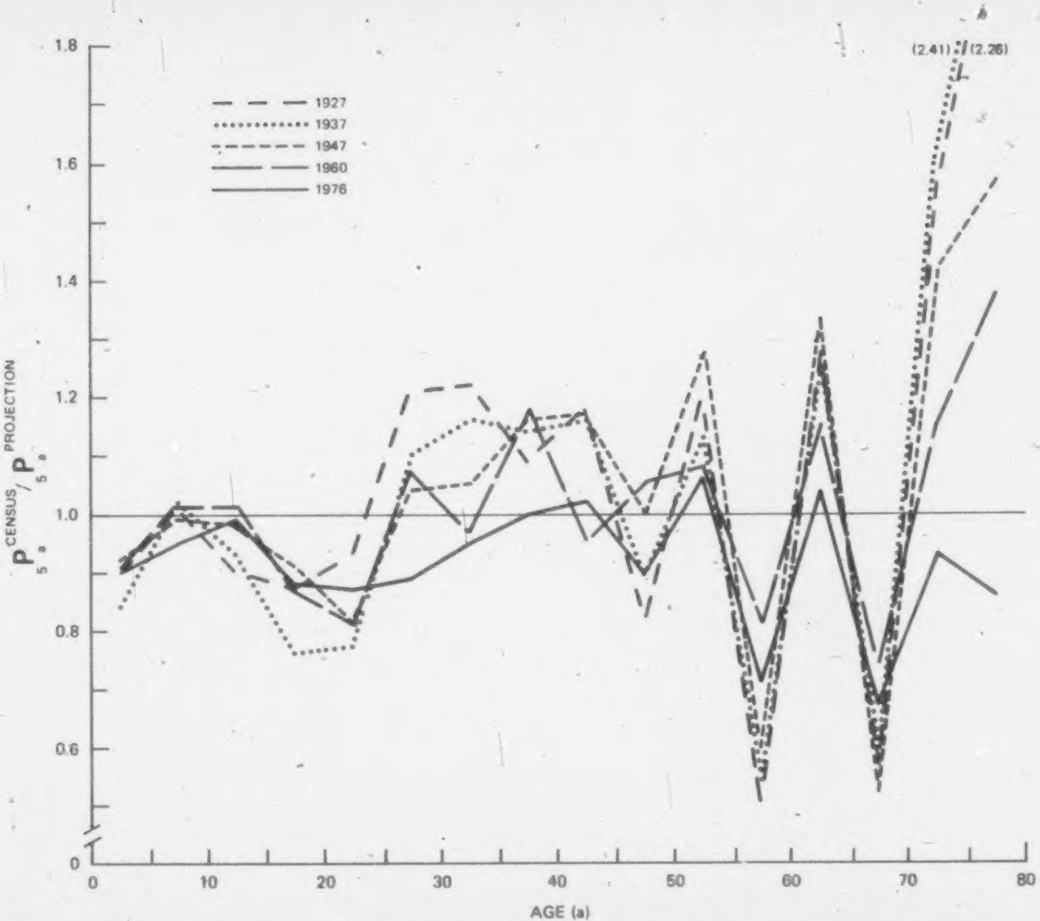


FIGURE D.2 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Females, 1927, 1937, 1947, 1960, and 1976: Egypt

distortion in the reported age distribution. Note in particular that the alternate ups and downs after age 50 are much smaller in 1976 than in the earliest censuses, and that the very strong overstatement of the male population over age 75 goes from 2.2 in 1927, to 2.1 in 1937, to 1.6 in 1947, to 1.5 in 1960, to no overstatement in 1976.

A notable feature of the 1976 census in comparison with the other four censuses is the lower ratio of enumerated to projected population between ages 25 and 45 or 50. This deficit of enumerated young adults relative to the projection, at ages at which the other censuses generally showed a greater enumerated than projected population, is probably the effect of the concentration at these ages of the population living abroad.

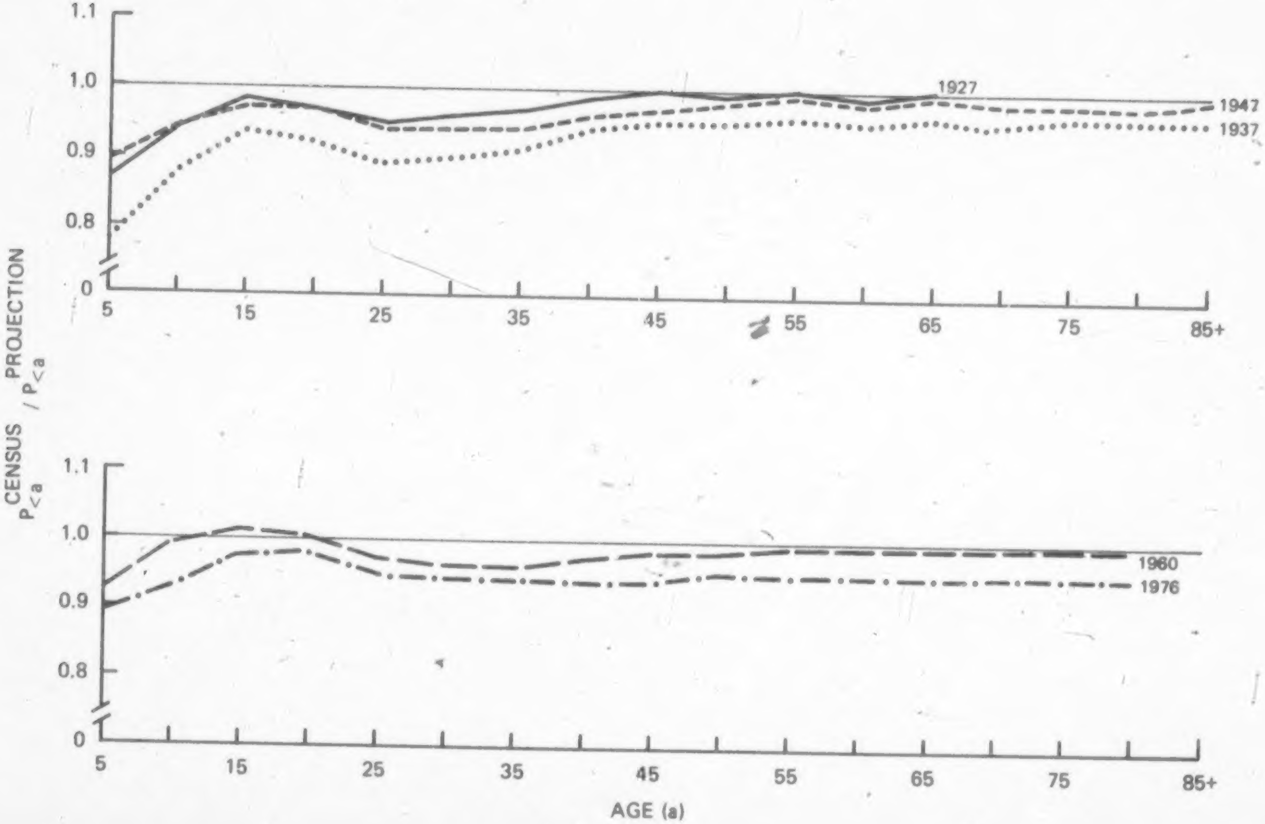
For females the ratios of enumerated to projected population show a puzzling irregularity in the 1960 census, with dips at 30-34 and 40-44, and peaks at 35-39 and 45-49, contrary to the other censuses. The irregularity occurs in the enumeration of females, not in the projection. In Figure D-3, in which the ratio males/females is shown by age for the five censuses, there is a structural similarity in the irregular patterns from one census to the next, with 1960 out of synchronization, one might say, with the others, from age 20 to age 50.

The comparison of the cumulated male and female enumerated populations with the cumulated projected populations in consecutive censuses (Figure D-4) shows the overall agreement in size and structure of the projected and observed populations. The pattern of the ratio of the recorded to the projected population is especially similar in the first three censuses, except that the 1937 ratio of census to projected is at all ages a few percent below the others. This suggests that the projected age structure is not far from the true structure, that the three censuses had very similar patterns of age misreporting and differential omission by age, and that the 1937 census was undercounted by some 3 or 4 percent more than the other two.

IMPLICATIONS OF THE RESULTS

What do the projections imply about the accuracy of our adjusted figures? We have already noted the small difference (0.74 per thousand) in the average rate of

MALES


$P^{CENSUS}_{<a} / P^{PROJECTION}_{<a}$
1.1
1.0
0.9
0.8
0
5
15
25
35
45
55
65
75
85+
1927
1947
1937
1.1
1.0
0.9
0.8
0
5
15
25
35
45
55
65
75
85+
1960
1976
AGE (a)

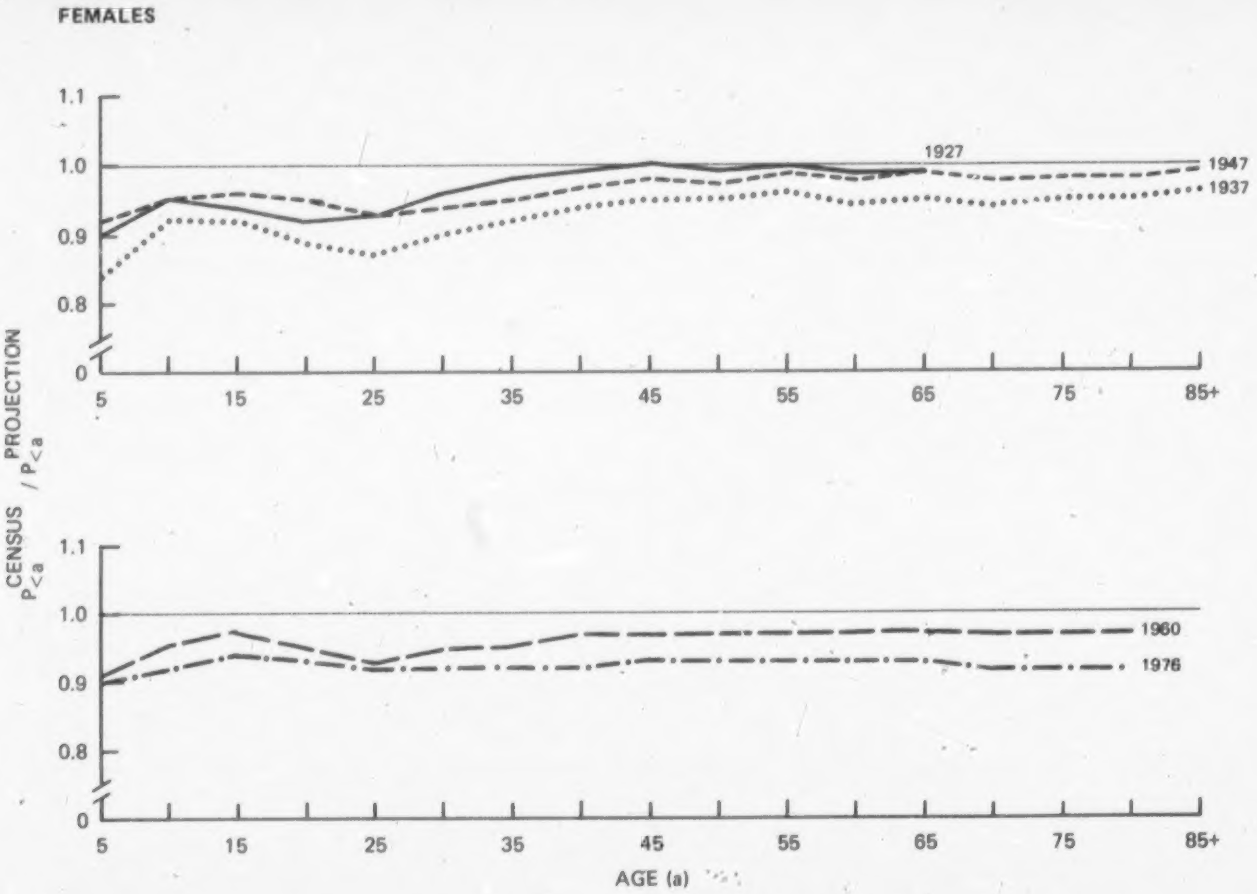


FIGURE D.4 Ratio of Cumulated Enumerated Population to Cumulated Projected Population, Males and Females, 1927, 1937, 1947, 1960, and 1976: Egypt

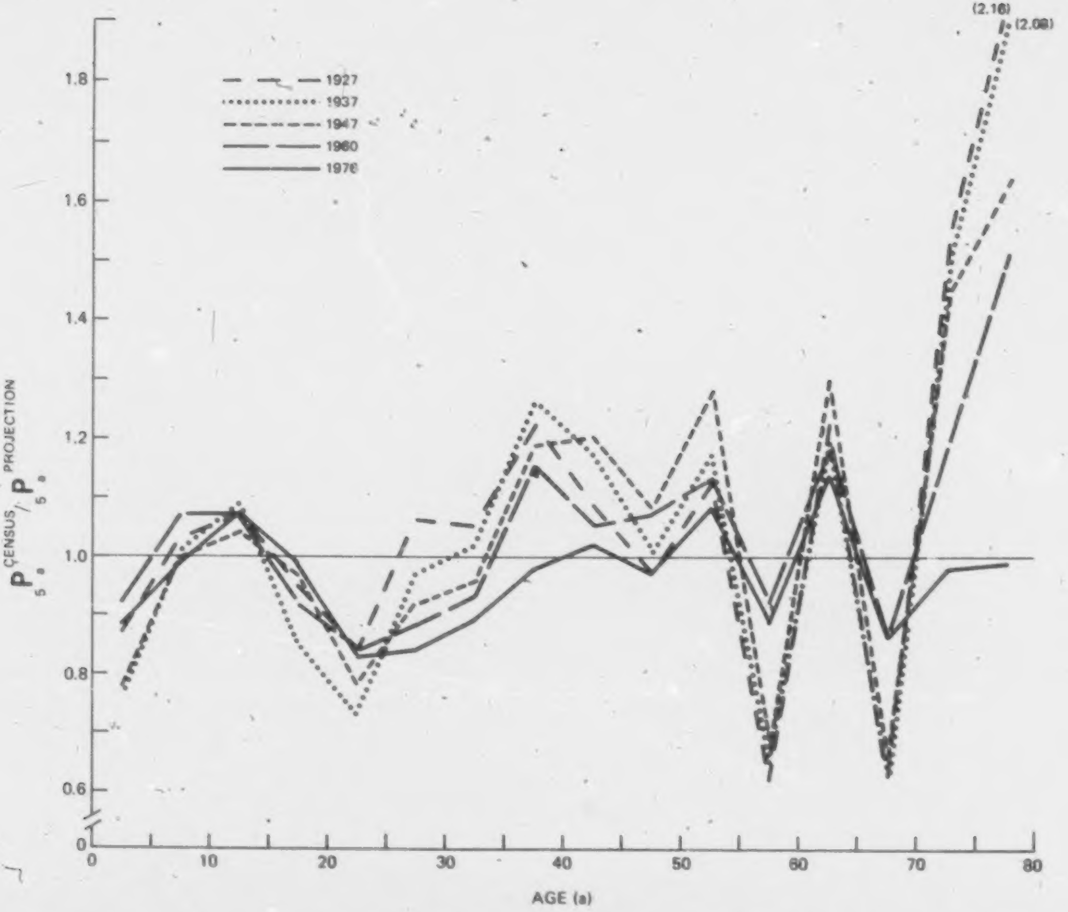


FIGURE D.1 Ratio of the Enumerated Population to the Projected Population by Five-Year Age Groups, Males, 1927, 1937, 1947, 1960, and 1976: Egypt

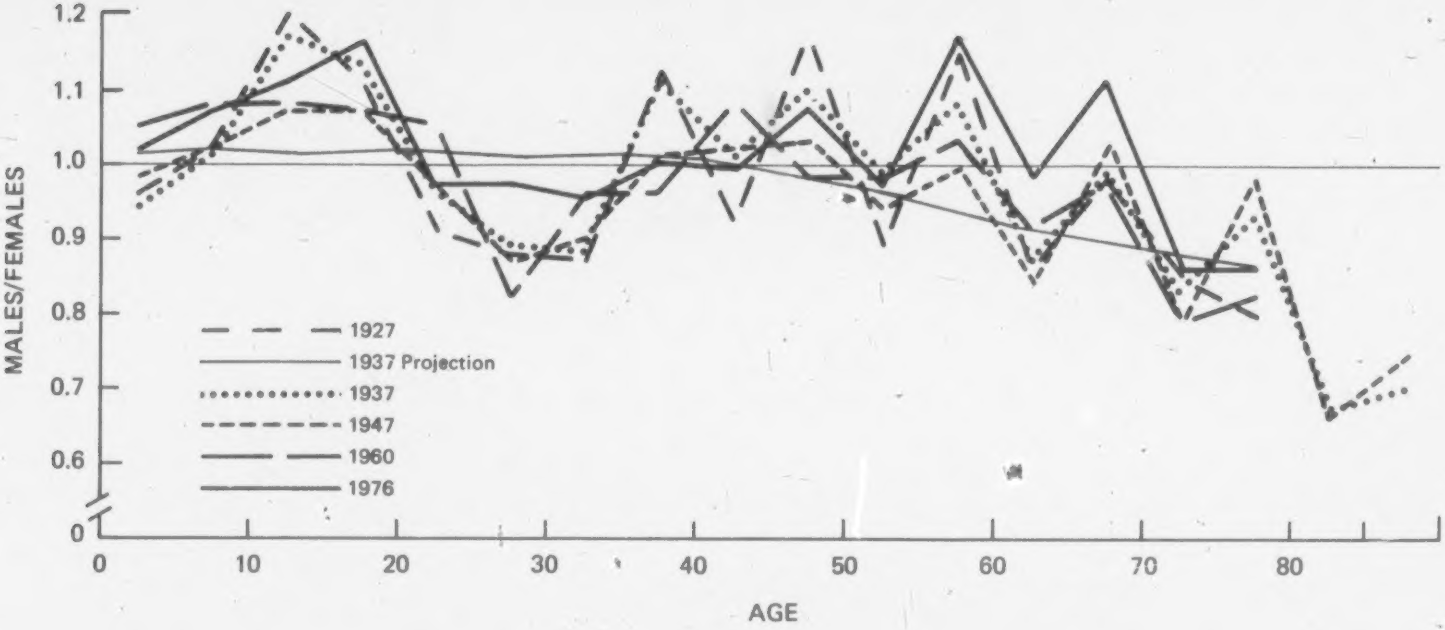


FIGURE D.3 Ratio of Males to Females by Age as Enumerated in the Censuses, 1927, 1937, 1947, 1960, and 1976, and in the Projected Population, 1937: Egypt

increase for 1927-76 between the enumerated and projected populations. This consistency in growth of numbers implies that the average difference between adjusted birth and death rates is about correct--but both might be too high or too low. The projected population is a little larger than the enumerated; if an error is implied in the estimated natural increase, it is that the estimated natural increase is slightly higher than the true value.

The most uncomfortable feature of our estimation is the selection of age-based values of estimated IMR from the 1947 census to compare with average infant mortality in 1946-47 in each governorate. This choice of rates for comparison combined the higher of the child survival estimates of IMR (age-based rather than duration-based) with a low set of registered IMRs--to avoid the imputation of substantial overregistration of IMR in a number of governorates. The result is a rather large adjustment of the IMR recorded in all Health Bureaus, a large adjustment that carries over to other years, leading to high levels of estimated IMR in the 1930s through the 1950s. These high rates, combined with corrected numbers of deaths at higher ages yield expectations of life at birth in the 1930s of only about 30 years.

If the infant mortality correction is too large, and the estimated infant mortality rates are too high, the projected population should fall short of the enumerated population--unless the estimates of the birth rate are also too high. The birth rate estimates, however, are taken from the Health Bureau areas (from 1927 to 1947) without adjustment. There is no apparent reason why these rates should be systematically too high.

The agreement of both the proportionate distribution and the aggregate size of the projected populations with the census populations, supports the approximate correctness of the estimated mortality and fertility rates. Cumulated percent distributions by age (projected and enumerated) are shown in Figure D-5. The census distribution is consistently lower at age 5, because of the usual tendency to undercount young children. The overall cumulative age structures are quite congruent, implying that the estimates of mortality and fertility are consistent with the structure as well as the growth of the Egyptian population.

There are, however, inconsistencies between the projected population and the population enumerated in the censuses that should be noted. An examination of the sequence of ratios (enumerated/projected) for the same age from census to census shows that the ratios in successive censuses for two cohorts (those 5-9 and 10-14 in 1927) are generally low (Figure D-6). These low ratios (at 15-19 and 20-24 in 1937, 25-29 and 30-34 in 1947, 40-44 and 45-49 in 1960, and 55-59 and 60-64 in 1976) imply that the stable population fitted in 1927 overstated the number at ages 5-9 and 10-14, and thus generated projected numbers too large for these cohorts in later censuses. Since the cohorts in question were born in 1912-16 and 1917-22, World War I and the influenza epidemic of 1918-19 may well have diminished their numbers.

Another inconsistency is the larger difference for females than for males between enumerated and projected populations, in later censuses and at older ages. These larger differences can be seen in a male-female comparison of the right-hand parts of Figure D-6. For example, note the age groups 55-59 and 65-69; the female differences are about twice as large as the male differences. Either there is a growing relative undercount of women, or our estimate of female mortality--although it includes a consistently higher estimate of the proportion of deaths omitted than for male mortality--should be slightly higher.

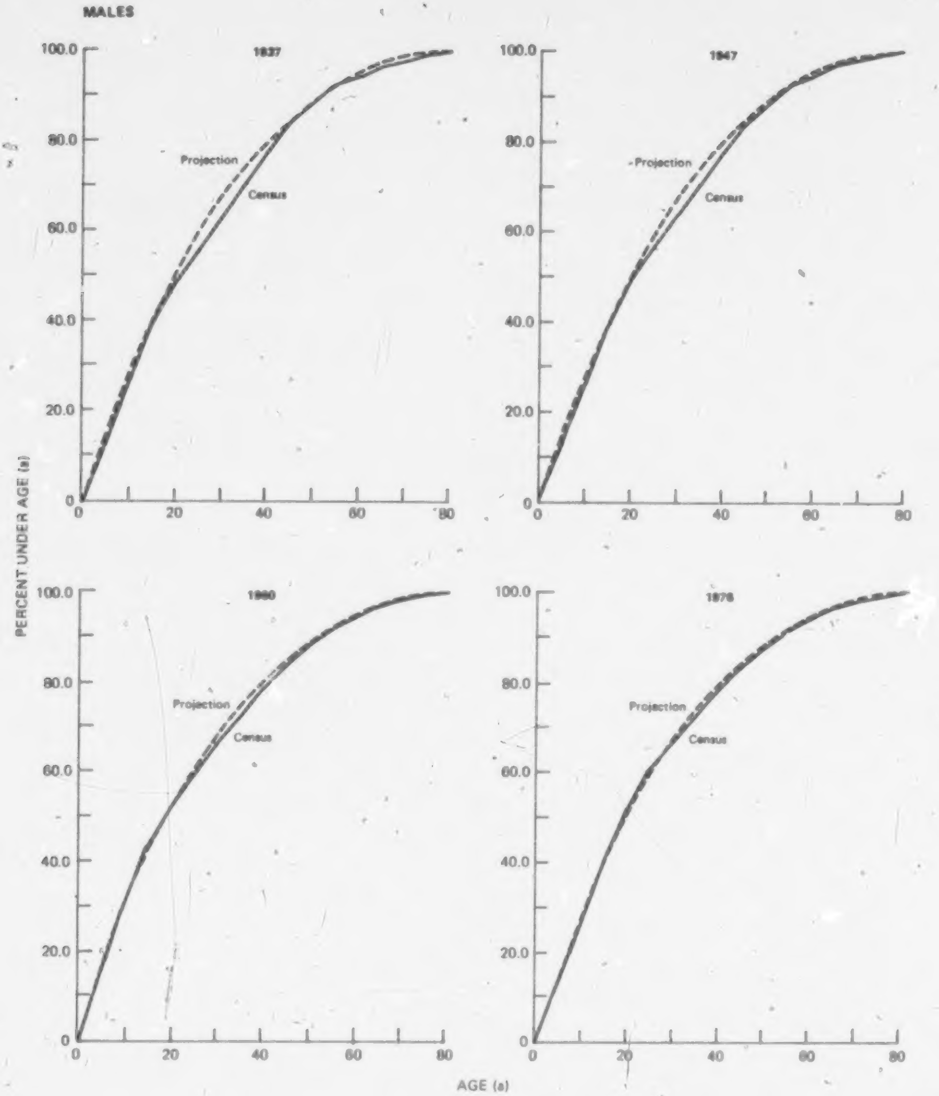


FIGURE D.5 Cumulated Percent Distribution by Age of the Enumerated and the Projected Population, Males and Females, 1937, 1947, 1960, and 1976: Egypt

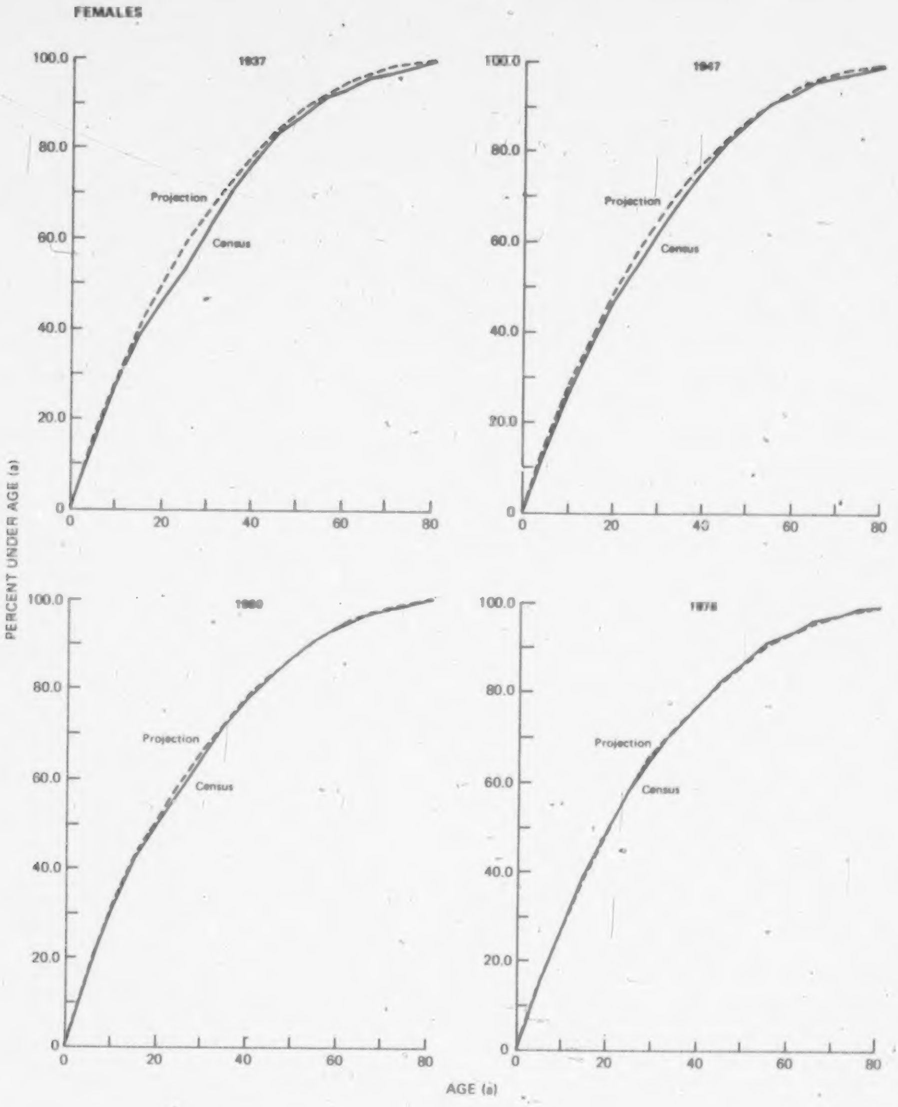


FIGURE D-5 (continued)

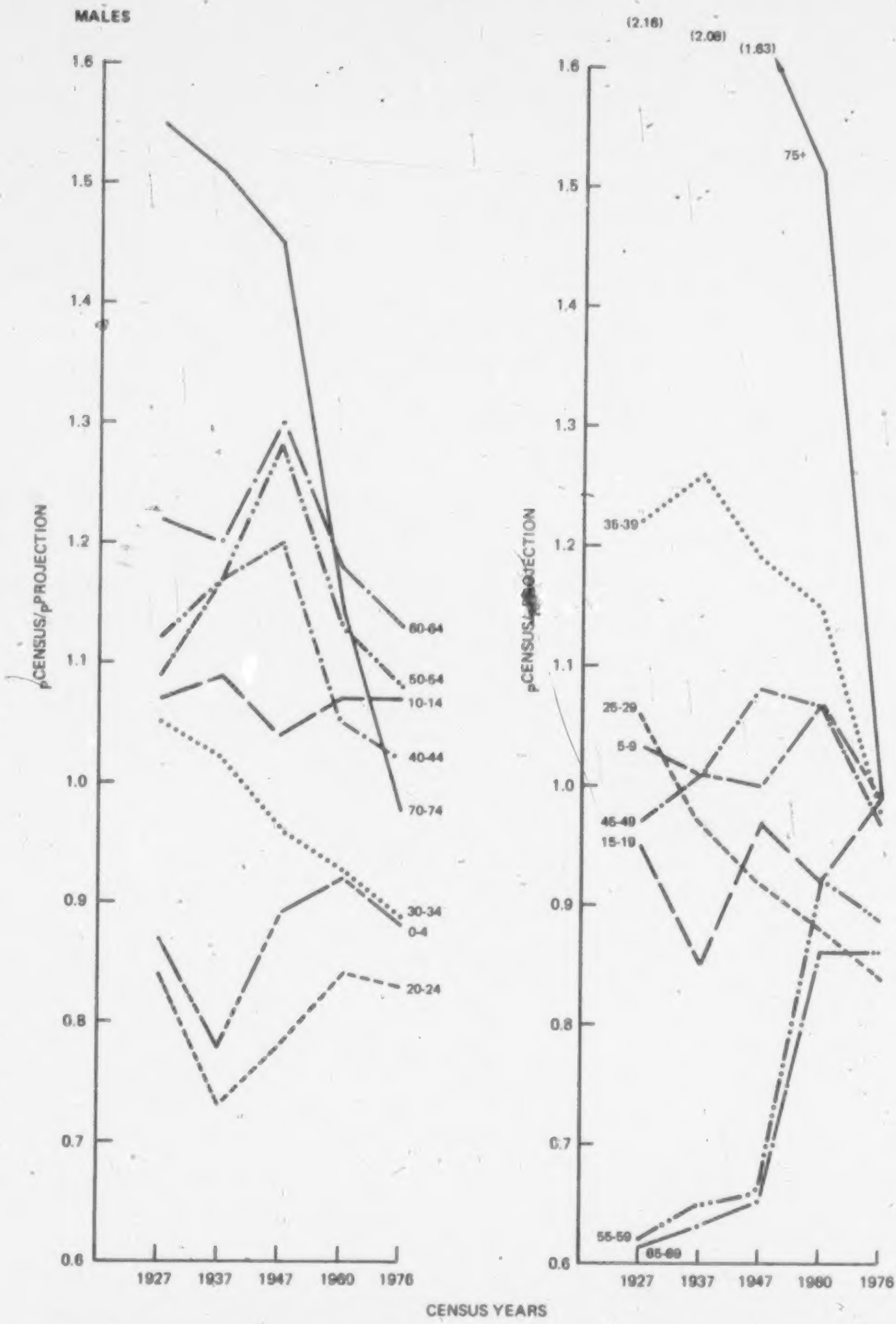


FIGURE D.6 Ratio of the Enumerated Population to the Projected Population by Age Groups, Males and Females, 1927, 1937, 1947, 1960, and 1976: Egypt

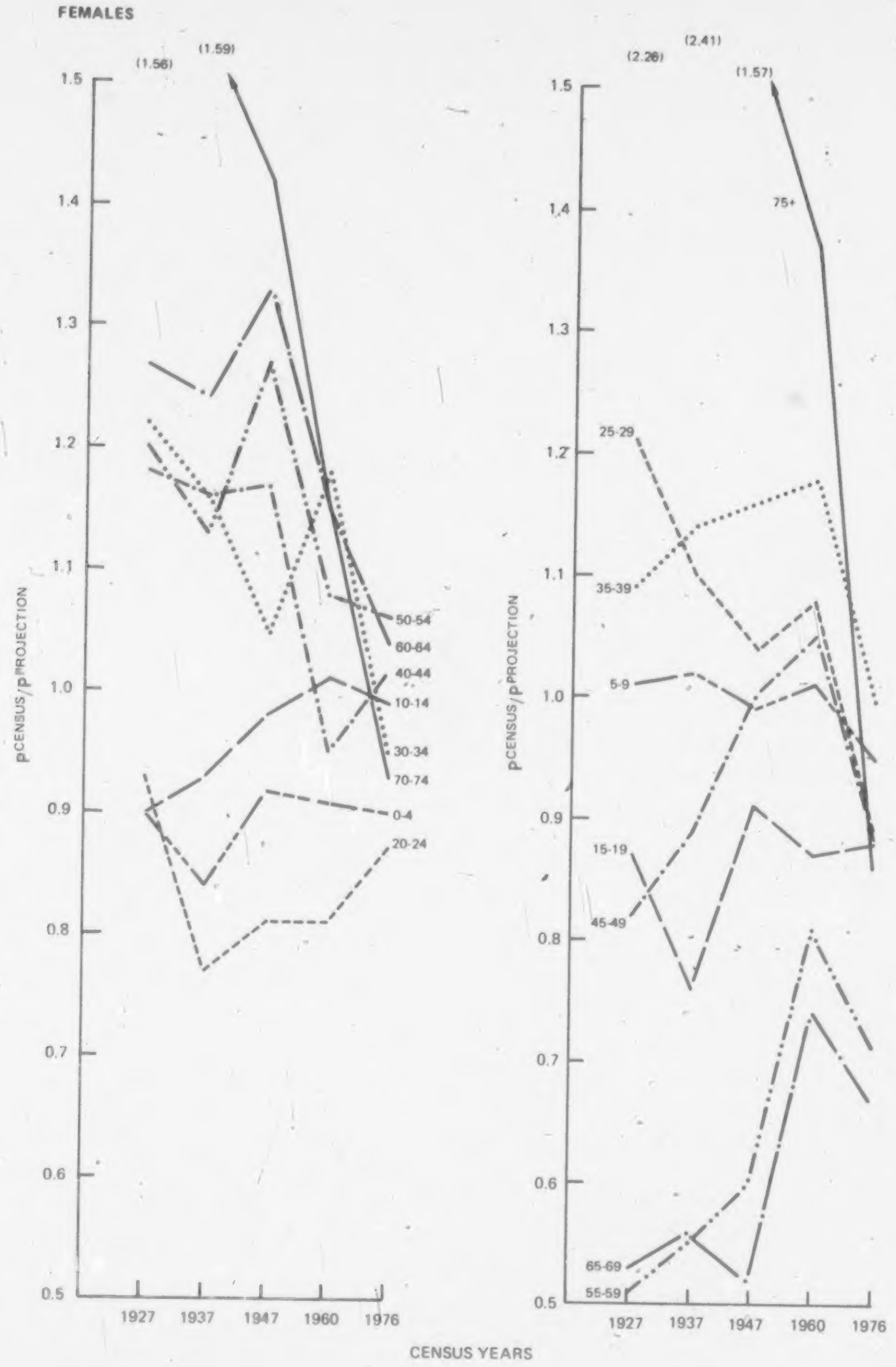


FIGURE D-6 (continued)

Appendix E

Underregistration of Marriages, 1948-60

In Appendix B it was noted that when the number of registered births in the 1950s is projected to the appropriate ages in 1960 and 1976, the calculated population falls short of the enumerated population by a larger margin than do projected populations of appropriate ages in 1937, 1947, 1960, and 1976 when based on registered births in the 1930s, 1940s, 1960s, and 1970s. In addition there were absurdly small numbers of births recorded in some districts in governorates in which the birth rate was especially low in 1956 or 1957 (or both).

In Appendix C, annual estimates of completeness of registration of deaths over age 10 revealed a decline in completeness for male deaths from nearly 100 percent up to 1947 to about 60 percent in the 1950s, and from 80 to 50 percent for female deaths, with a subsequent recovery.

In this appendix, we show that the recording of marriages also deteriorated in the 1950s. The absolute number of recorded first marriages was above 182,000 in every year but one (1947) from 1942 through 1950 and was below 182,000 in every year but one (1960) from 1951 through 1962. The ratio of the number of first marriages to a crude estimate of the number of women at the mean age of first marriage is shown in Figure E-1. (The mean age at first marriage was a little less than 20 years during this period; the divisor used in the ratio is the interpolated number of females at ages 10 to 29, divided by 20.) Since very few Egyptian women remain single, this "first marriage rate" would be expected to have an average value near 1.0, unless the mean age at first marriage changed. (A rise in mean age at marriage of one year reduces the expected number of marriages over a period of a few years by the number that would normally

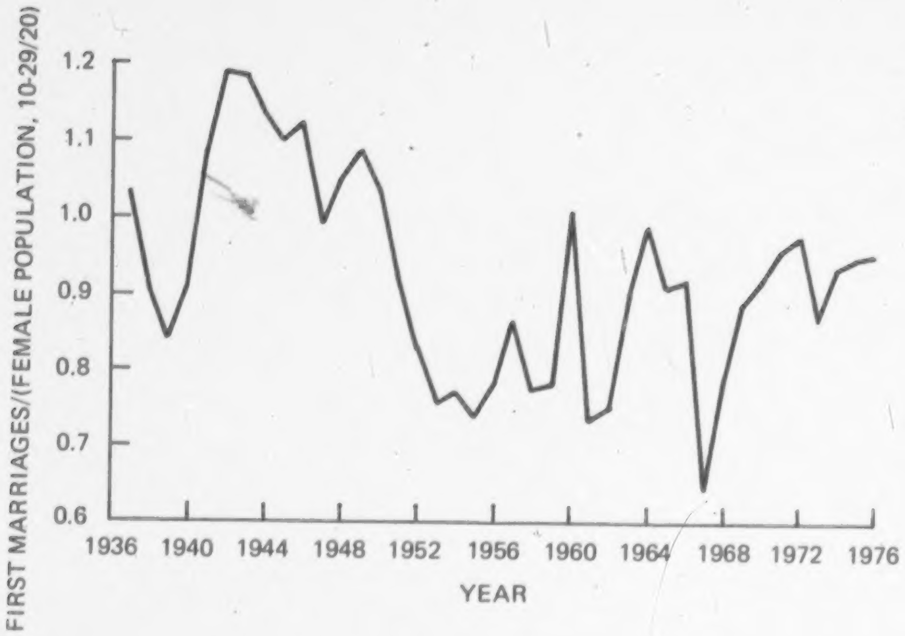


FIGURE E.1 "First Marriage Rate" Measured as the Ratio of Registered First Marriages to One-Twentieth the Female Population Aged 10 to 29, 1937-76: Egypt

occur in one calendar year.) The rate does indeed oscillate about 1.0 from 1947 to 1950 but then falls to very much lower values during the 1950s. Clearly, the low absolute number of reported first marriages after 1950 was not the result of a reduced number of women of eligible age.

If the number of first marriages and the first marriage rate had truly fallen as the reported figures indicate, it could be inferred that the mean age at marriage rose, and that more young women remained single. In fact, it appears that the fraction of registered first marriages in which the bride was less than 20 years old was higher in the 1950s than in the 1940s (see Figure E-2). Moreover, the proportion ever married at young ages in the 1960 census was virtually the same as in the 1947 census. The number of first marriages recorded in the 10 years before the 1947 census (1.632 million) was 107.1 percent of the number of ever married women less than 30 years old reported in the

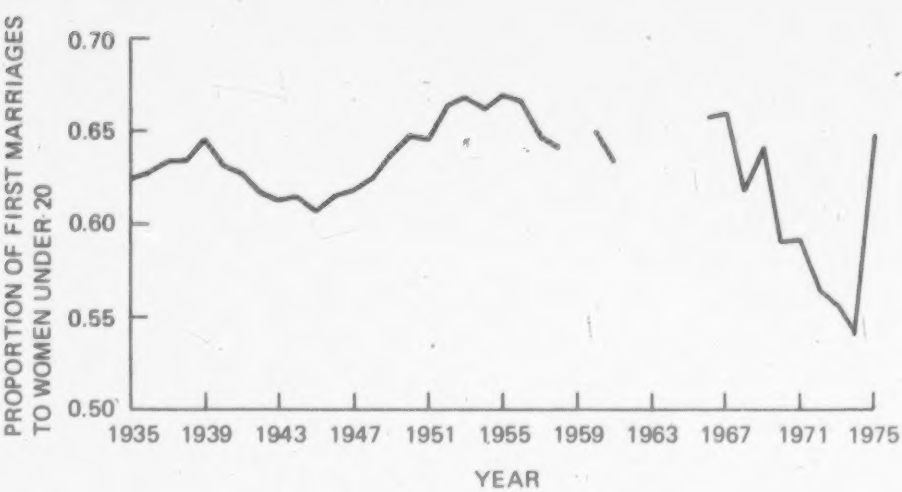


FIGURE E.2 Proportion of Registered First Marriages Occurring to Women Under the Age of 20, 1935-75: Egypt

census. In 1960 the 1.706 million first marriages recorded in the 10 preceding years was 79.2 percent of the reported number of ever married women less than 30; in 1976 the 2.750 million first marriages in the 10 preceding years was 96.1 percent of the recorded number of ever married women less than 30. The decline in the ratio of first marriages to ever married women from 1.07 to .96 from 1947 to 1976 is in small part the result of declining mortality (more of the first married died before the census in the 1940s), but the decline of the ratio to .792 in 1960 suggests the omission of many marriages in the registered figures. This finding is consistent with the evidence of underregistration of births and deaths during the 1950s.

Appendix F

An Analyis of Underregistration of Births and Deaths in Egypt Based on a CAPMAS Survey, 1974-75

Underregistration of vital events is common in most developing countries. As described elsewhere in this report, Egyptian vital statistics suffer from varying degrees of underregistration of births and deaths. Underregistration occurs particularly in rural areas and especially in rural areas that do not have Health Bureaus, where births and deaths are normally registered. The Central Agency for Public Mobilisation and Statistics (CAPMAS) therefore undertook a survey aimed at continuously observing vital events in a representative sample, recording such events, and checking whether they were reported to the Health Bureaus.

The survey covered the two calendar years 1974 and 1975. A sample of about 2.5 percent of small administrative units (the village in rural areas and the district in urban areas) was selected. The sample included 43 urban districts (Shiyakhas) and 105 villages, representing the following strata: Urban areas: Cairo and Alexandria, urban centers in Lower Egypt (excluding the Canal Zone, not covered by the survey), and urban centers in Upper Egypt; Rural areas: rural Lower Egypt and rural Upper Egypt. Once a district or village was selected, all households therein were covered, except in large urban districts where, in order to reduce the number of households to be covered, an area including about 1,000 households was selected from within each sample district. The size of the sample population in each stratum is shown in Table F-1. The sample was designed to provide reliable estimates of the completeness of birth and death registration, and estimates of fertility and mortality, for five major geographic and urban-rural divisions of Egypt.

About half the sample units were surveyed in 1974 and half in 1975. The data collection consisted of (1) a "census" of all households and individuals, on a basis that included both de facto and de jure elements; (2) four visits to each household, at three-month intervals, in which all changes were recorded, including births, deaths, pregnancies by duration, and other additions to the household and departures from the household; (3) preparation of lists of births, deaths, and stillbirths from the records of the Health Bureau to which each sample district or village belongs. At the end of the year, the lists prepared from the Health Bureau records were compared with corresponding lists prepared from the results of the household visits.

Matching procedures included the following features:

(a) Unmatched cases were checked in both sources, first with the concerned Health Bureau staff and second with the household itself.
(b) Although the analyses were done on a de jure basis, events that occurred to any sample-area household member outside the sample area were considered matched if the household had any official document that proved the registration.
(c) Since a birth may have an appellation name plus an official name registered in the civil registration records, such cases were considered matched after assuring that the birth referred to the same person.
(d) Events that occurred to persons in the sample areas were considered matched if it was found that the event was registered in any Health Bureau, even if that Bureau was not located within the Health Bureau area of the interviewed household.
(e) Some births registered in the civil registration records were found later to refer to births that occurred in years preceding the survey year, i.e., these births were recorded with erroneous birth dates. Events in this category were disregarded in the matching process, in order to avoid false non-matches.

In a survey of this nature, many details of the survey operation and the matching can affect the results, and adjustments may be necessary. Two significant adjustments were made in the survey data. One adjustment was aimed at correcting an error arising from the difference between

TABLE F-1 Underregistration of Births by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Births: Recorded in Survey and in Registration System	Recorded in Registration System Only	Recorded in Survey Only	Total	Estimated Under-registration (percent)
Cairo and Alexandria	54,314	1,156	19	28	1,203	2.33
Urban Lower Egypt	87,492	2,623	66	150	2,839	5.28
Urban Upper Egypt	66,740	2,373	54	250	2,677	9.34
Rural Lower Egypt	265,380	8,176	745	1,098	10,019	10.96
Rural Upper Egypt	221,200	6,858	840	2,490	10,188	24.44
All Egypt (weighted)[a]						12.36

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[a] The weights are the total births in 1974-75 as given in the vital statistics of the registration system.

de facto and de jure registration of births. Although in Egypt it is a legal requirement to register a birth in the locality of occurrence (de facto), births are frequently reported in the locality of residence (de jure) when the latter differs from locality of birth. Such erroneous reporting was substantial in Cairo and Alexandria where 24 percent of the sample births took place outside the locality of residence, compared to only 1 to 3 percent in all other regions, urban and rural. Treating such births as non-matches would have introduced a substantial matching error in the data for these two cities. Hence in the follow-up inquiry among unmatched cases, each family was asked whether a reported birth was registered and whether a birth certificate or a ration card showing date of birth could be shown to the interviewer. This information was used to allocate births that took place outside the locality of residence according to whether or not they were registered, i.e., procedure (b) above was applied.

The second adjustment was necessary to correct a bias due to the existence of delayed registration beyond the cut-off date adopted for matching purposes. The matching of births reported during the household visits, against births appearing in registration records was continued only through the end of February of the year following the year of birth (that is, the 1974 births were followed up in the registration records through February 1975 and the 1975 births through February 1976). Thus any 1974 or 1975 births which were registered after February of the next year were erroneously counted as not registered (unmatched). To adjust for this error, a distribution of births by interval between birth and registration was calculated for each region, to provide an estimate of the births expected to be registered after February of the next year. For instance, the number of December births was multiplied by a correction factor equal to the proportion of total births registered more than two months after birth. Similarly for November births the correction factor was based on the proportion registered more than 3 months after birth, and so on. The correction factors derived this way are acceptable if no seasonal pattern of registration delay exists. Fortunately, no such pattern was evident for any region.

In rural Upper Egypt the resulting correction factors were 14 percent for December births, 9 percent for those of November, and declining amounts for October, etc. down to .5 percent for May births. The percentages were somewhat smaller in rural Lower Egypt and much smaller in urban areas. In Cairo and Alexandria and in urban Lower Egypt the correction factors were 2 percent and 1 percent for December and November births respectively.

SUMMARY OF RESULTS

Tables F-1, F-2, and F-3 present, respectively, the number of births, deaths, and infant deaths recorded in both sources (household interview and registration system), and in one source only, either interview or registration. The estimated number of events missed in both sources, calculated by the Chandrasekar-Deming formula (see Glossary), was not included because of doubts regarding independence between the two sources, at least in some regions.

As expected, underregistration of births in urban areas, except in Upper Egypt, is quite limited: a little over 2 percent in Cairo and Alexandria and 5 percent in urban Lower Egypt. The percentage is higher in urban Upper Egypt, about 9 percent. Even in rural Lower Egypt underregistration is moderate, approximately 11 percent. It is only in rural Upper Egypt that underregistration of births is quite serious: one out of four births is not registered, according to this survey. These regional results weighted by total births 1974-75 given in civil registration data, lead to an estimate of underregistration for the whole country of a little over 12 percent for the 2-year period 1974-75.

The picture is similar--and surprisingly of the same magnitude--in the case of mortality (see Table F-2). In Cairo and Alexandria underregistration of deaths is only a little over one percent. In other regions, underregistration of deaths is close to the level of underregistration of births: 6 percent in urban Lower Egypt, 11 percent in urban Upper Egypt, 9 percent in rural Lower Egypt, and 28 percent in rural Upper Egypt, giving a weighted average of 13 percent for the whole country.

The serious effect of underregistration of infant deaths on overall underregistration is demonstrated by comparing Tables F-2 and F-3: between 56 and 77 percent of the non-registered deaths in the sample were infants, without a regional pattern, e.g., in urban Lower Egypt there were 35 infant deaths among a total of 62 deaths in the category "recorded in survey only," or 56 percent. For infant deaths, underregistration ranges from 4 percent in the two large cities to 55 percent in rural Upper Egypt (see Table F-3).

The tendency not to register an infant death either as a death or as a birth was confirmed by survey results: among all unregistered infant deaths, 86 percent were not registered as births either. This percentage was 94 among infant deaths below one month of age, 88 and 83 respectively among those who died at age one and two months, 60 percent among infants dying between the ages of 3-5 months, and 43 percent among infants who died in the age range 6-11 months.

GENERAL COMMENTS

While the above findings appear reasonable and acceptable, it must be emphasized that there are several unanswered questions regarding the accuracy of the data. One unknown is the adequacy of the sample selected in each region. There is also uncertainty about the matching procedures, specifically the extent to which cases whose registered names differed from those reported in the interviews were investigated (procedure c noted above). The practice of de jure instead of de facto registrations causes another problem. Although the law requires that a birth be registered in the locality where it occurred, (and naturally a small percentage of families do so even though they reside elsewhere), for mothers who delivered in a sample area but live elsewhere the completeness of registration of their births is difficult to assess, in part because many of these mothers were not available for interview.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by $_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol ${}_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by l(x). The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by e(x); the probability of surviving from each age x to age x + n, denoted by ${}_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by ${}_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is 1/2 ln[p/(1 - p)]. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x (${}_xq_0$) is related linearly to the logit of a standard probability of dying by age x (${}_xq_0^s$) so that

$$\text{logit}\ ({}_xq_0) = \alpha + \beta\ [\text{logit}\ ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationsh[illegible] and other characteristics available from a censu[illegible] survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in

TABLE F-2 Underregistration of Deaths by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Deaths: Recorded in Survey and in Registration System	Number of Deaths: Recorded in Registration System Only	Number of Deaths: Recorded in Survey Only	Number of Deaths: Total	Estimated Under-registration (percent)
Cairo and Alexandria	54,314	502	11	7	520	1.35
Urban Lower Egypt	87,492	807	98	62	967	6.41
Urban Upper Egypt	66,740	892	69	115	1,076	10.69
Rural Lower Egypt	265,380	3,052	492	360	3,904	9.22
Rural Upper Egypt	221,200	2,411	479	1,122	4,012	27.97
All Egypt (weighted)[a]						12.83

[a] The weights are the total deaths in 1974-75 as given in the vital statistics of the registration system.

TABLE F-3 Underregistration of Infant Deaths by Region, 1974-75: Egypt

Region	Total Sample Population	Number of Infant Deaths: Recorded in Survey and in Registration System	Recorded in Registration System Only	Recorded in Survey Only	Total	Estimated Under-registration (percent)
Cairo and Alexandria	54,314	95	33	5	133	3.76
Urban Lower Egypt	87,492	179	17	35	231	15.15
Urban Upper Egypt	66,740	248	15	88	351	25.07
Rural Lower Egypt	265,380	578	42	262	882	29.71
Rural Upper Egypt	221,200	481	36	645	1,162	55.51
All Egypt (weighted)[a]						33.46

[a] The weights are the total infant deaths in 1974-75 as given in the vital statistics of the registration system.

different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived ($_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, $_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

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